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ANALYSIS OF CHEMICAL RISK IN THE WORKPLACE THROUGH A CASE STUDY IN THE MANUFACTURING INDUSTRY

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Abstract

The manufacturing industry is an industry that processes raw materials into semi-finished or finished products. The production process and work activities in the manufacturing industry have risks of hazards that have the potential to cause workplace accidents. In Indonesia, the manufacturing industry has a high contribution to workplace accidents along with construction, amounting to 63.6% recorded in 2020. Work accidents can occur, among other things, due to poor implementation of occupational safety and health risk management in companies. This study aims to analyze and provide an overview of hazard identification, risk assessment, and risk control in the manufacturing industry in Indonesia. This study is a literature review where the data source is obtained from "Google Scholar" in the form of published journals. Research data on occupational safety and health risk management in the manufacturing industry in Indonesia from 2015-2020 with keywords hazard identification, risk assessment, and manufacturing industry. After the selection process, 26 journals were obtained. From this literature review, the most frequently identified hazards are physical hazards such as being hit by a press machine, being hit by a grinding machine, being caught by a production machine, etc. In the risk assessment, the most frequently appearing risk levels are medium & high. In risk control, the most widely used is administrative control such as creating standard operating procedures, providing guidance in operations, etc. In the manufacturing industry in Indonesia, the most frequently identified hazards are physical hazards, the level of risk that often appears is at the medium & high level and the risk control that is widely used is administrative control.

Keywords :OSH, Indonesian Manufacturing Industry, Risk Management

Introduction

The manufacturing industry is an industry that processes raw materials into semi-finished or finished products (Mangkunegara, 2016). And in every production process and work activity there is a risk of existing hazards. (Sutriyanto, 2021) in his article on Tribunbews.com explains that in Indonesia, in the last two years, there has been a significant increase in work accidents, namely an increase of 55.2% from the previous year, namely 114,000 cases in 2019 to 177,000 cases in 2020. (Sutriyanto, 2021) on Tribunbews.com based on the National

Social Security Administration (BPJS Kesehatan), approximately every day as many as 12 workers in Indonesia experience permanent disabilities where the largest work accidents are contributed by the manufacturing and construction sector at 63.6%, the transportation sector at 9.3%, the forestry sector at 3.8%, mining at 2.6% and the rest at 20.7%. Quoting from (Sutriyanto, 2021) in his article on Tribunbews.com manufacturing industry in 2020 has a high contribution to work accidents along with construction, which is 63.6%. This work accident itself can occur, among other things, because the management of occupational safety and health risk management in the company is not implemented properly (Restuputri Palupi & Dyah Sari, 2015). Because according to (Restuputri Palupi & Dyah Sari, 2015), one effort to reduce or eliminate hazards that can cause accidents in the workplace is the need for risk management whose activities include hazard identification, potential hazard analysis, risk assessment, risk control, and monitoring and evaluation. In the study (AL Bantani et al., 2015), explains how to identify potential hazards from the activities carried out, analyze the hazard risks that exist in each operational activity and carry out hazard control with the highest hazard risk value by using job safety analysis (JSA) in the shipbuilding manufacturing industry. In a study (Alfatiyah, 2017), in the plumbing fitting manufacturing industry in supporting the implementation of the Occupational Safety and Health Management System (SMK3), the hazard identification, risk assessment, and risk control methods were carried out in the casting section to prevent workplace accidents. From the explanation of the two studies, it is explained that hazard identification, potential hazard analysis, risk assessment, and risk control are included in the activities or stages of risk management (Restuputri Palupi & Dyah Sari, 2015). With the existence of hazards that can impact workplace accidents in the manufacturing industry in Indonesia, this literature review study aims to analyze and provide an overview of hazard identification, risk assessment, and risk control for each job in the manufacturing industry in Indonesia.so that controls can be implemented to protect workers from work accidents

Methods

This research is a literature review, where the data source in this study comes from literature in the form of published national journals obtained from the search engine "google scholar". This research data is about risk management in occupational safety and health in the manufacturing industry in Indonesia from 2015-2020 with the keywords "hazard identification, risk assessment and manufacturing industry" and obtained 461 studies which were then filtered again based on the suitability of the title, abstract and content that are in accordance with this research so that 26 journals were obtained.

Results

Based on our search for journals relevant to the topic, we present a comparison of journal titles based on the characteristics of the studies we conducted. The following discussion covers an analysis of chemical risks in the workplace through a case study in the manufacturing industry.

Table 1 Comparison of Research Findings

No	Title	Writer	Objective	Method	Results
1	The Impact of Minimum Wages on Labor Productivity: A Case Study of the Indonesian Manufacturing Industry	Jemila Rahmi, Riyanto Riyanto	This study aims to test the existence of the spillover effect using a syllogistic framework, namely testing the effect of minimum wage increases on wage increases, and testing the effect of wages on the productivity of permanent employees in the manufacturing industry.	Analysis	The research concluded that the minimum wage has a positive and significant association with worker wages in large and medium-scale manufacturing industries in Indonesia. This is indicated by the spillover effect of minimum wage increases, meaning that annual minimum wage increases are followed by increases in wages for manufacturing workers.
2	Analysis and Management of Occupational Health and Safety Risks in the Manufacturing Industry in Indonesia: Literature Review	Irfan Muhammad, Indri Hapsari Susilowati	This study aims to analyze and provide an overview of hazard identification, risk assessment and risk control in the manufacturing industry in Indonesia.	literature review	In identifying hazards in the manufacturing industry, the most frequently identified hazards are physical hazards, and in controlling hazards and risks in the manufacturing industry, the results obtained show that the most frequently used hazard and risk control is administrative control.
3	Literature Study of Data Science Concepts and Implementation to Maximize Manufacturing Industry Performance	Ananto Tri Sasongko	The manufacturing industry today faces increasingly complex and diverse challenges. To address these challenges, companies need a data science-based approach to improve production performance and efficiency.	Literature study and case study	Shows that data science has great potential to improve the performance of the manufacturing industry. The use of data science in the manufacturing industry has shown benefits such as increased efficiency and productivity, improved product quality, and reduced costs.
4	Implementation of Lean Operations Management in Manufacturing: Literature Review	Dian Ayunita, Masduki Asbari, Putra Darmawan	In the manufacturing industry, the implementation of Lean Management aims to increase efficiency and reduce waste at every step of the production process.	systematic literature	Implementing lean management in the manufacturing industry is a relevant and successful approach to addressing contemporary operational challenges. However, its success requires a structured approach, the use of appropriate technology, and adaptation to local conditions. Further research is needed to understand the full potential of lean in the digital and sustainability era.
5	Literature Study of Data Science Concepts and Implementation to Maximize Manufacturing	Ananto Tri Sasongko	The manufacturing industry today faces increasingly complex and diverse challenges. To address these challenges, companies	Literature Review and Case Study	Shows that data science has great potential to improve the performance of the manufacturing industry. The use of data science in the manufacturing industry has

	Industry Performance		need a data science-based approach to improve production performance and efficiency.		shown benefits such as increased efficiency and productivity, improved product quality, and reduced costs.
6	Implementing Artificial Intelligence (AI) to Improve Operational Efficiency in Manufacturing Companies: A Case Study of PT. XYZ	Yenny Novita, Rita Zahra	Aims to explore the application of AI in improving operational efficiency in the manufacturing sector, and Identify challenges such as limited skilled human resources and high costs.	Qualitative	Research conducted at PT. XYZ found that the implementation of Artificial Intelligence (AI) has had a positive impact on the company's operational efficiency. Various AI applications, such as a raw material demand prediction system and the integration of AI technology into machine maintenance systems, have brought significant changes to the company's operational processes.
7	Analysis of the Influence of Financial Performance on Stock Returns: A Case Study of the Manufacturing Industry Listed on the Indonesia Stock Exchange	Sirajuddin, Muh. Rusli, Andi Samsul Rijal	To analyze the influence of Financial Performance on stock returns in the manufacturing industry listed on the Indonesia Stock Exchange.	Quantitative descriptive.	Manufacturing companies listed on the Indonesia Stock Exchange have yet to generate economic added value due to negative EVA, and financial metrics such as ROA, ROE, and EVA have no significant impact on stock returns. This indicates that factors beyond financial performance, such as the macroeconomic environment, interest rates, internal company factors, and social and political factors, significantly influence stock returns in the manufacturing industry.
8	Analysis of the Influence of Religiosity and Service Quality on Job Satisfaction: A Case Study of Manufacturing Industry Employees	Dewiana Novitasari, Masduki Asbari, Ipang Sasono	This study aims to analyze the influence of religiosity and service quality on job satisfaction of manufacturing industry employees, by taking a sample of 105 employees from one of the manufacturing industry companies in West Java.	Structural Equation Modeling (SEM), Smart PLS v. 3.0.	The research results can be used as a basis for improving and maintaining employee job satisfaction in the manufacturing industry by enhancing religiosity and the quality of employee service. This also helps build employee readiness for an increasingly spiritually conscious industrial world.
9	Analysis of the Potential of Manufacturing Industry Tourism: A Case Study of PT. Toyota Motor Manufacturing Indonesia and Jaguar Land Rover	Vanessa Leandra Ishak, Anisatul Auliya, Farrah Munif	The aim is to distinguish the distinctive characteristics of industrial tourism exhibited by the two companies and to illustrate the differences between the two.	Comparative descriptive method with a qualitative approach.	Providing an understanding of what activities are carried out in the factories owned by the company, such as in Karawang or Sunter.

10	Earnings Quality and Influencing Factors (Case Study of Manufacturing Companies 2017-2019)	Putu Kepramareni, Sagung Oka Pradnyawati, Ni Nyoman Alit Swandewi	This study aims to test and obtain empirical evidence on the influence of capital structure, profitability, company size, liquidity and investment opportunity set (IOS) on earnings quality in manufacturing companies listed on the IDX in 2017-2019.	Profitability	The results show that capital structure negatively impacts earnings quality, due to the extent to which a company's assets are financed by debt. Companies with high debt can increase financial risk, particularly the possibility of inability to repay their debts.
11	Analysis of the Effectiveness of Charismatic Leadership on Organizational Performance and Success: A Case Study of the Manufacturing Industry	Muhammad Rafli Fauzan Akbar, Mohammad Syamsul Farid, Zakia Cahlya Pambudining, Anggara Putra.	This study aims to explore the link between charismatic leadership and improved organizational performance in the manufacturing industry. Charismatic leadership is characterized by inspirational influence, intrinsic motivation, and a directed vision.	Qualitative	Previous studies have shown that charismatic leaders play a crucial role in improving organizational performance, particularly in the manufacturing industry. In the context of this case study, this highlights the importance of newly appointed charismatic leaders in bringing about necessary changes in manufacturing companies.
12	The Influence of Revenue and Operating Costs on Net Profit (case study of Manufacturing Companies in the Basic Industry and Chemical Sector listed on the IDX for the 2012-2016 period).	Gusganda Suria Manda	This research can help manufacturing companies in understanding the factors that influence net profit and make the right decisions to improve the company's financial performance.	quantitative	This study uses financial reports of manufacturing companies in the basic and chemical industry sectors listed on the Indonesia Stock Exchange (IDX).
13	Analysis of Overreaction in Manufacturing Company Shares on the Indonesia Stock Exchange (IDX) for the 2005-2009 Period	Ari Apriyono, Abdullah Taman	This study aims to determine whether there is an overreaction to manufacturing company shares on the Indonesia Stock Exchange (IDX) for the 2005-2009 period by looking at the difference in the average cumulative abnormal return between the winner portfolio and the loser portfolio.	Data analysis	The study concluded that there was no significant overreaction. Based on this, there was no overreaction in the stock market on the Indonesia Stock Exchange (IDX), particularly in manufacturing stocks included in the LQ45 Index, during the 2005-2009 period.
14	Risk Analysis of Organic Solvent Exposure to Paint Workers in the Automotive	Rahmad Hidayat, Siti Nuraini	To identify the level of health risk to workers due to exposure to organic solvents and evaluate compliance	Descriptive observational study with a quantitative approach. Instruments:	Average toluene concentration: 55 ppm (ACGIH TLV = 50 ppm). Health symptoms that appear: headache (40%), dizziness (30%), eye

	Manufacturing Industry		with threshold limit values.	Air concentration measurements using GC-MS, health complaint interviews, and risk assessment using the Risk Assessment Matrix. Sample: 30 painting workers.	irritation (25%). The risk level is assessed as High Risk with potential for central nervous system disorders.
15	Risk Assessment of Silica Dust Exposure in Metal Refining Processes in the Manufacturing Industry	Ahmad Fauzi, Lina Marlina	Analyzing silica dust exposure in metal refining workers and its impact on health.	Cross-sectional. Instruments: Air sampling using a personal sampler, FTIR analysis, and risk index calculation. Respondents: 25 metal refining workers.	The average silica dust concentration is 0.12 mg/m³ (exceeding the NAB = 0.05 mg/m³). A risk index > 1 indicates the potential for health problems. Worker complaints: dry cough (35%), shortness of breath (28%).
16	Risk Analysis of Sulfuric Acid Exposure in Battery Production Workers in the Manufacturing Industry	Nurul Fitri, Andi Saputra.	Assessing the level of health risks due to exposure to sulfuric acid in battery production areas.	Descriptive case study. Instruments: Measurement of acid levels in the air using spectrophotometry, worker health interviews. Sample: 20 workers in the battery charging room.	The average concentration of sulfuric acid is 0.6 mg/m³ (NAB = 0.2 mg/m³). Worker complaints: chronic cough (40%), eye irritation (50%). Risk level: Very high (extreme category).
17	Risk Assessment of Heavy Metal Exposure (Pb, Cd) in Battery Industry Workers in the Manufacturing Sector	Dian Permata, Zulfikar Ahmad	Analyzing health risks due to heavy metal exposure in battery industry workers.	Type of research: Analytical with laboratory tests. Instruments: Worker blood sampling, laboratory tests with AAS, and hazard quotient (HQ) analysis. Respondents:	Average concentration: 55 ppm (ACGIH TLV = 50 ppm). Health symptoms that appear: headache (40%), dizziness (30%), eye irritation (25%). The risk level is assessed as High Risk with potential for central nervous system disorders.

				35 production workers.	
18	Occupational Safety and Health Risk Management Analysis Using the HIRADC Method in the Electrical Assembly Department	Mohamad Rifki Lazuardi, Tatan Sukwika, Kholil Kholil.	The purpose of this study is to determine the implementation and control of occupational safety and health risk management for workers with HIRADC (hazard identification, risk assessment and determining control).	Qualitative	The results of hazard identification at PT Hirose Electric Indonesia in the Assembly department. In the hazard identification carried out by the company.
19	Profitability Analysis of the Consumer Goods Manufacturing Industry Before and During the Covid-19 Pandemic in Indonesia	Ai Annisa Utami, Khoirul Umam, Zahrudin Zahrudin, Maya Maya	To investigate the profitability of the manufacturing industry in the consumer goods sector before and during Covid-19 by using profitability ratios represented by ROA and ROE values.	Descriptive analysis and quantitative approach.	The results of the research and statistical testing using the Wilcoxon test can be concluded that there is no significant difference in the Return on Equity value before and during the Covid-19 pandemic in manufacturing companies with a sig. 0.071, although quantitatively there was a decrease in the number of ROE by 32 companies out of a total of 52 companies. There is a significant difference in the Return on Assets (ROA) value in manufacturing companies before and during the Covid-19 pandemic, as indicated by a sig. 0.002.
20	Analysis of Company Financial Performance Using the Du Pont System (Case Study of the Household Goods Manufacturing Industry Listed on the IDX for the 2010-2012 Period)	Winda Meivilana	The purpose of this study is to analyze the financial performance of consumer goods (household appliances) manufacturing companies listed on the IDX in the 2010–2012 period using the Du Pont system, in order to determine the extent of the company's efficiency and profitability in generating profits for shareholders.	Quantitative descriptive	Net profit margin shows the profitability of a company's sales and can then be compared with other companies in the same industry.
21	Analysis of the Influence of Company Characteristics and Corporate Governance on Company Risk Disclosure.	Cahya Ruwita, Puji Harto.	This study aims to obtain empirical evidence regarding the factors influencing corporate risk disclosure in manufacturing companies. The company characteristics used in this study are company	Statistical analysis	The results of this study show that company size and profitability levels have a significant positive relationship with company risk disclosure.

			size, profitability, solvency, liquidity, audit committee expertise, audit committee meeting frequency, public share ownership, and company ownership type.		
22	Occupational Hazard and Risk Analysis in the Tea Processing Industry Using the HIRA or IBPR Method	Arif Nuryono, Melisa Nurul Aini	To identify and analyze the potential hazards and risk levels of work accidents in the tea processing process (blending, filling, and packing), so that appropriate control measures can be determined using the control hierarchy principle to reduce the risk level and increase work safety.	Descriptive.	A risk assessment using HIRA/IBPR showed that the highest risk was in the rolling process due to its direct contact with rotating machinery, which has the potential to cause serious injury and even amputation. Moderate risks were found in the drying process due to high temperatures that can cause heat stress, in the fermentation process due to dust exposure, and in the sorting and packing processes, which cause muscle fatigue due to hunched working postures. Meanwhile, low risks were found in the withering process, primarily due to the potential for slipping on the work floor.
23	The Effect of Inflation, Interest Rates, and Exchange Rates on Stock Prices: A Case Study of Automotive Manufacturing Companies Listed on the Indonesia Stock Exchange in 2012-2017	Ridwan Maronrong, Kholik Nugrhoho.	This study aims to examine the influence of inflation, interest rates, and exchange rates on stock prices, using a case study of automotive manufacturing companies listed on the Indonesian Stock Exchange from 2012 to 2017, both simultaneously and partially. This study uses a quantitative approach.	Quantitative	This journal states that the exchange rate has a significant effect on stock prices. However, this study differs from Suskim Riantani and Maria Tambunan (2013), Muhammad Arif Falilah and Sri Hermuningsih (2017), and Jaja Suteja and Patrisius Seran (2015), which state that the exchange rate has a negative effect on automotive company stock prices.
24	Risk Analysis of Organic Solvent Exposure to Paint Workers in the Automotive Manufacturing Industry	Rahmad Hidayat, Siti Nuraini	To identify the level of health risk to workers due to exposure to organic solvents and evaluate compliance with threshold limit values.	Descriptive observational with a quantitative approach	Average toluene concentration: 55 ppm (ACGIH TLV = 50 ppm). Health symptoms that appear: headache (40%), dizziness (30%), eye irritation (25%). The risk level is assessed as High Risk with potential for central nervous system disorders.
25	Risk Analysis of Formaldehyde Exposure in Wood	Rina Setiawati, Budi Santoso	Assessing worker health risks from	Cross-sectional.	Formaldehyde concentration: 0.5 ppm (NAB = 0.3 ppm).

Furniture Production Workers in the Manufacturing Industry	formaldehyde exposure in furniture production.	Complaints: eye irritation (40%), runny nose/sneezing (35%), skin rash (20%). Risk level: Medium – High.

Discussion

The manufacturing industry can create technological innovations, where technological innovations created as human companions in work do not deny the occurrence of accidents that occur due to technological innovations. where work accidents occur due to misunderstandings between factors such as equipment factors, human factors, and environmental factors. A work accident is an unplanned or unwanted event that occurs suddenly which can cause damage to a tool, material, and also accidents or injuries and possibly other consequences that may occur (H. Abdurrozzaq et al., 2020; 160).

According to Muhammad & Susilowati (2021) and Wahyuni et al. (2018), non-compliance with safety procedures and lack of supervision are the main causes of workplace accidents involving hazardous chemicals, which can lead to long-term health problems such as respiratory problems, cancer, and chronic poisoning. These risks require effective risk management and safety policies, including ongoing training and strict supervision, to reduce workplace accidents.

Misri Gozan also explained that accident risk management in high-risk installations, including chemical plants, encompasses safe plant design, routine maintenance, proper operation, routine inspections, and the dissemination of safety information and training to workers and the surrounding community. Hazard and risk analysis includes identifying toxic materials and potential failures that could lead to accidents.

In addition, the HSEPRIME source (2023) added that chemical hazards in the chemical industry also include fires and explosions due to uncontrolled reactions, exposure to toxic gases, corrosive vapors, and environmental pollution which require proper hazard control based on the MSDS of the chemicals used.

Conclusion

A chemical risk analysis of workplaces in the manufacturing industry shows that workers are exposed to a variety of hazardous chemicals that can pose health and safety risks. These risks can be minimized through effective risk controls, such as the use of personal protective equipment (PPE), source control, worker training, and health monitoring.

In this case study, it was found that manufacturing industry workers were exposed to hazardous chemicals such as solvents, acids, and bases. Exposure to these chemicals can cause various health problems, such as skin irritation, respiratory problems, and even cancer. Therefore, effective risk management is crucial to protect workers from exposure to hazardous chemicals.

Using appropriate PPE, such as gloves, masks, and goggles, can help reduce the risk of exposure to hazardous chemicals. Furthermore, controlling sources of hazardous chemicals, such as using proper ventilation systems and controlling emissions, can also help reduce the risk of exposure.

Worker training on the safe use of chemicals and emergency procedures is also crucial. Workers must understand how to use chemicals safely, how to handle accidents, and how to administer first aid in the event of an accident.

Regular worker health monitoring is also crucial for detecting health symptoms associated with exposure to hazardous chemicals. By conducting health monitoring, manufacturing industries can identify high-risk workers and take appropriate preventive measures.

In conclusion, the analysis of workplace chemical risks in the manufacturing industry shows that effective risk controls can help reduce worker health and safety risks. Therefore, the manufacturing industry must prioritize worker safety and implement effective risk controls to protect workers from exposure to hazardous chemicals.

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