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Article

Industrial Environmental Health as an Effort to Prevent Environmental Impacts and Occupational Diseases

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ABSTRACT

Industrial activities have the potential to generate negative impacts on the environment and human health if they are not properly managed. Industrial environmental health plays a crucial role in preventing environmental pollution and occupational diseases through systematic control of environmental factors and industrial hygiene practices. This study aims to analyze the role of industrial environmental health as an integrated preventive framework for environmental pollution and occupational health disorders. This research employed a qualitative literature review approach by analyzing scientific articles, textbooks, and regulatory documents related to industrial environmental health published between 2015 and 2024. The findings indicate that integrated control of air emissions, wastewater management, solid waste handling, and workplace environmental factors significantly reduces pollution risks and occupational disease incidence. Furthermore, the study highlights that the implementation of industrial environmental health not only protects workers and the surrounding environment but also contributes to improved industrial performance through enhanced productivity, regulatory compliance, and operational sustainability. Therefore, this study contributes by emphasizing the integration of environmental health management and occupational health protection as a strategic approach to achieving sustainable industrial operations.

1. Introduction

Industrialization is one of the main pillars of a country's economic development. Industrial growth contributes to job creation, increased community income, and accelerated regional development. However, behind these benefits, industrial activities often generate waste and emissions that have the potential to pollute the environment. Uncontrolled air, water, and soil pollution can cause various health problems, affecting both industrial workers and communities living around industrial areas.

Industrial environmental health is a scientific discipline and management practice that plays a crucial role in balancing economic progress in the manufacturing sector with the protection of ecosystem sustainability and human health. In operational practice, industrial environmental health is no longer viewed narrowly as end-of-pipe waste management but has evolved into a holistic approach encompassing the entire product life cycle and internal workplace environmental safety for workers. Along with increasing global awareness of climate change impacts and the latent risks of hazardous pollutants, industries are required to adopt stricter standards to mitigate chemical, physical, and biological contamination risks.

The importance of industrial environmental health is based on the fact that large-scale production activities often involve intensive energy use, toxic chemicals, and physical processes that generate hazardous emissions or residues. Without adequate control systems, these contaminants can infiltrate environmental media such as air, groundwater, and soil surfaces, ultimately triggering chronic health problems in the broader community and reducing workforce productivity. Therefore, the implementation of appropriate environmental health standards serves as a preventive barrier against the emergence of occupational diseases and ecological disasters that may harm corporate reputation and long-term financial sustainability.

Industrial environmental health thus becomes a key aspect in preventing such negative impacts. This approach emphasizes controlling physical, chemical, and biological environmental factors to ensure they remain within safe thresholds for human health and environmental protection.

By understanding the concept of industrial environmental health early on, industry stakeholders are expected not only to pursue profitability targets but also to fulfill ethical responsibilities in maintaining the quality of life for future generations. This article discusses how environmental impact prevention measures can be integrated with occupational health protocols to create industrial synergy that is safe, clean, and sustainable.

Although numerous studies have examined industrial environmental health and occupational safety, most research still focuses partially on technical aspects of waste treatment or occupational safety alone. Studies that holistically integrate environmental impact prevention with worker health protection remain limited, particularly in the Indonesian industrial context.

Despite the growing body of research on industrial environmental health and occupational safety, most existing studies tend to focus on environmental pollution control or occupational health protection as separate domains. Limited attention has been given to integrative approaches that simultaneously examine environmental impact prevention and occupational disease mitigation within a unified industrial environmental health framework. This gap is particularly evident in the context of developing countries, where industrial growth often outpaces environmental and occupational health management systems. Therefore, this study addresses this gap by synthesizing environmental management and occupational health perspectives into a comprehensive preventive framework, highlighting their interdependence in supporting sustainable industrial performance.

Based on this background, this study aims to analyze the role of industrial environmental health in preventing environmental pollution and occupational health disorders.

2. Literature Review

Industrial environmental health has been widely discussed as an essential component in preventing environmental pollution and occupational diseases in industrial settings. Previous studies emphasize that industrial activities inherently generate physical, chemical,

and biological hazards that may adversely affect both the environment and worker health if not properly managed (Rizal, 2015; Salami, 2022). Therefore, industrial environmental health serves as a preventive system aimed at controlling environmental risk factors within acceptable health and safety thresholds.

Several studies highlight the relationship between industrial pollution and public health outcomes. Muliani and Rijal (2018) explain that uncontrolled industrial waste contributes to environmental degradation and changes in community health structures, particularly through increased respiratory and skin diseases. Similarly, Mena et al. (2019) found that industrial environmental impacts significantly influence the quality of life of communities residing near industrial areas, especially through air and water pollution exposure.

From an occupational health perspective, research consistently shows that workplace environmental conditions are strongly associated with occupational disease incidence. Indriyani et al. (2017) demonstrated that prolonged exposure to wood dust in industrial settings increases respiratory health risks among workers. Anwar (2024) further emphasized that poor environmental conditions and work-related stress contribute to decreased occupational safety and health performance, increasing the likelihood of work-related illnesses and accidents.

The application of industrial hygiene principles has been identified as an effective approach to mitigating these risks. Setyaningsih (2018) and Eni (2021) describe industrial hygiene as a systematic effort to identify, evaluate, and control environmental hazards in the workplace. Engineering controls, proper waste management systems, and regular environmental monitoring are considered more effective than reliance on personal protective equipment alone.

Recent studies also underline the importance of integrated environmental and occupational health management. Fadlillah and Sukma Pawitra (2020) reported that industries complying with environmental health standards demonstrate better environmental performance and lower occupational health risks. Hutapea et al. (2024) showed that structured risk identification programs contribute significantly to the prevention of occupational diseases by

promoting early hazard recognition and preventive action.

Despite the extensive discussion on environmental pollution control and occupational health protection, most existing literature still treats these aspects separately. Limited studies comprehensively integrate environmental impact prevention and occupational disease control within a single industrial environmental health framework, particularly in developing country contexts. This gap indicates the need for a holistic approach that simultaneously addresses environmental sustainability and worker health protection.

Therefore, this study builds upon previous research by synthesizing environmental health management and occupational health perspectives into an integrated preventive framework. By emphasizing the interdependence between environmental protection and occupational health, this study contributes to strengthening sustainable industrial practices and supports the development of comprehensive industrial environmental health strategies.

3. Research Methodology

This study employed a qualitative descriptive approach to examine the role of industrial environmental health in preventing environmental pollution and occupational health disorders. The research focused on the analysis of documents and policy materials related to industrial environmental health practices, environmental pollution control, and occupational health protection.

Data sources consisted of official regulations, technical guidelines, and documented practices in the field of industrial environmental health published between 2015 and 2024. These documents were selected based on their relevance to environmental pollution prevention and occupational health protection in industrial settings.

Data analysis was conducted using thematic analysis. The collected data were systematically reviewed and categorized into four main themes: air pollution prevention, water pollution prevention, soil pollution prevention, and prevention of occupational health disorders. This thematic classification enabled an in-depth understanding of the implementation of industrial environmental

health measures and their contribution to environmental protection and the prevention of occupational diseases

4. Results and Discussion

4.1 Prevention of Environmental Impacts (Air, Water, and Soil)

The literature consistently demonstrates that preventive measures implemented at pollution sources are more effective than end-of-pipe approaches in reducing environmental risks. For instance, air emission control technologies such as scrubbers and filtration systems not only reduce particulate matter but also minimize long-term exposure risks for surrounding communities. This indicates that early-stage environmental interventions play a strategic role in mitigating public health impacts while simultaneously supporting regulatory compliance.

Similarly, effective wastewater management systems contribute to the protection of aquatic ecosystems and reduce health risks associated with contaminated water use. Comparative findings across multiple studies suggest that industries implementing integrated wastewater treatment experience fewer environmental complaints and improved environmental performance, highlighting the broader operational benefits of environmental health management beyond pollution control alone.

4.2 Air Pollution Prevention

The main focus of air pollution prevention is controlling exhaust gas emissions and particulate matter to avoid atmospheric contamination and respiratory health disturbances.

1. Installation of Emission Control Devices:
 - a. Dust collectors or baghouse filters to capture fine particulate matter.
 - b. Scrubbers to neutralize acidic gases such as SO₂ and other toxic gases.
 - c. Electrostatic precipitators (ESP) to capture fly ash in large-scale industries such as power plants.
2. Process and Raw Material Modification:

Replacing volatile organic compounds (VOCs) with more stable materials and using high-efficiency combustion

equipment to reduce carbon monoxide emissions.

3. Routine Maintenance:

Regular calibration of chimneys and industrial machinery to ensure complete combustion and minimize soot emissions.

4.3 Water Pollution Prevention

The primary goal of water pollution prevention is to ensure that industrial wastewater does not damage aquatic ecosystems or infiltrate community drinking water sources.

1. Optimization of Wastewater Treatment Plants (WWTP):
 2. Physical treatment through sedimentation and filtration.
 3. Chemical treatment using coagulants and flocculants to bind heavy metals and hazardous substances.
 4. Biological treatment using microorganisms to decompose organic pollutants, such as activated sludge systems.
2. Application of the 3R Principle (Reduce, Reuse, Recycle):

Reusing treated wastewater for cooling systems or cleaning processes to reduce discharge volumes.
3. Separate Drainage Systems:

Separating rainwater drainage from industrial wastewater channels to prevent overflow during heavy rainfall.

4.4 Soil Pollution Prevention

Soil acts as the final absorber of pollutants; therefore, prevention focuses on securing solid waste to avoid long-term contamination that damages soil structure.

- a. Management of Hazardous and Toxic Waste (B3):

Waste storage in impermeable facilities with protective dikes to prevent chemical leakage into the soil. Strict labeling and packaging to prevent unintended chemical reactions.
- b. Standardized Final Disposal Sites:

Use of impermeable liner layers to prevent leachate from seeping into groundwater.
- c. Bioremediation and Phytoremediation:

Planting certain vegetation around industrial areas that can absorb soil pollutants as a natural protective measure.

4.5 Prevention of Occupational Health Disorders

Literature findings consistently demonstrate that effective control of noise and dust exposure plays a critical role in reducing occupational disease risks. Comparative analysis across multiple studies indicates that industries implementing engineering controls and preventive maintenance experience lower absenteeism rates and improved worker productivity, suggesting that environmental health interventions provide both health and operational benefits.

Factories that install sound dampeners on large machinery create quieter work environments, which can reduce the risk of hearing loss and work-related stress caused by excessive noise. In addition, proper air circulation within production areas is highly effective in removing hazardous chemical vapors. Workers are less exposed to strong odors and chemical dust, thereby reducing the risk of lung damage and impaired organ function. The use of standard-compliant personal protective equipment remains mandatory to prevent toxic substances from entering the body through inhalation or skin contact. Occupational health disorder prevention in industrial workplaces focuses on controlling environmental risk factors through industrial hygiene approaches and strict health standards.

4.6 Hierarchy of Risk Control

To prevent occupational diseases, industries must implement five levels of hazard control based on priority:

1. Elimination: Removing hazard sources entirely.
2. Substitution: Replacing hazardous materials or processes with safer alternatives.

3. Engineering Controls: Modifying work environments, such as installing local exhaust ventilation systems.
4. Administrative Controls: Regulating work patterns, training, and warning signage.
5. Personal Protective Equipment (PPE): Mandatory use of respirators, earplugs, and protective clothing.

In practice, the effectiveness of the hierarchy of risk control depends on consistent implementation and organizational commitment. Industries that prioritize elimination and substitution strategies demonstrate more sustainable risk reduction compared to those relying primarily on personal protective equipment. This indicates that proactive engineering and management interventions yield more significant long-term occupational health benefits.

4.7 Environmental and Occupational Health Standards

Industries in Indonesia adhere to environmental quality standards covering physical, chemical, and biological factors, including noise levels, lighting, chemical exposure thresholds, and biological hazards.

4.8 Integration of Industrial Environmental Health and Industrial Performance

Beyond health and environmental protection, industrial environmental health contributes directly to industrial performance outcomes. Studies indicate that improved workplace environmental conditions reduce occupational illness, absenteeism, and work-related fatigue, leading to increased productivity and operational efficiency. Moreover, effective environmental management enhances regulatory compliance, reduces environmental penalties, and strengthens corporate reputation. Therefore, industrial environmental health should be viewed not only as a compliance obligation but also as a strategic investment that supports long-term industrial sustainability and competitiveness.

Table 1. Summary of Industrial Environmental Health Literature in Preventing Environmental Impacts and Occupational Diseases

No	Analysis Theme	Control Focus	Key Findings	Environmental and Health Impacts	Sources
1	Air Pollution Prevention	Emission and particulate control	Emission control through scrubbers, filtration systems, and routine equipment maintenance is more effective than end-of-pipe approaches in reducing air pollution risks	Reduces respiratory disorders among workers and surrounding communities and supports compliance with air quality standards	Muliani & Rijal (2018); Ratna & Rochmani (2020); Setyaningsih (2018)
2	Water Pollution Prevention	Industrial wastewater management	Integrated wastewater treatment systems (physical, chemical, and biological processes) significantly reduce pollutant loads before discharge into the environment	Protects aquatic ecosystems and reduces health risks associated with contaminated water use	Mena et al. (2019); Nursidiq et al. (2021); Fadlillah & Sukma Pawitra (2020)
3	Soil Pollution Prevention	Solid and hazardous waste (B3) management	Proper handling of hazardous waste and the application of bioremediation methods prevent long-term soil contamination	Maintains soil quality and prevents groundwater contamination	Rizal (2015); Salami (2022); Ratna & Rochmani (2020)
4	Prevention of Occupational Health Disorders	Industrial hygiene and risk control	Noise control, adequate ventilation, and implementation of the hierarchy of controls reduce the incidence of occupational diseases	Improves worker health, reduces absenteeism, and enhances productivity	Indriyani et al. (2017); Anwar (2024); Hutapea et al. (2024)
5	Integration of Environmental Health and Industrial Performance	Integrated environmental management	The implementation of industrial environmental health contributes to improved operational performance and regulatory compliance	Supports industrial sustainability and harmonious relationships with surrounding communities	Fadlillah & Sukma Pawitra (2020); Eni (2021); Salami (2022)

4. Conclusion

Blanching time had a significant effect on the quality of avocado leaf herbal tea with added cinnamon powder. Treatment L4, with a blanching time of 15 minutes, was selected as the best treatment, yielding a moisture content of 4.11%, ash content of 6.46%, the highest antioxidant activity with an IC₅₀ value of 41.66

ppm (classified as very strong), and a tannin content of 0.012%. The descriptive sensory scores of the herbal tea were 2.33 (yellow) for color, 2.67 (slightly grassy) for aroma, and 2.47 (not bitter) for taste. The hedonic scores preferred by panelists were 3.74 (like) for color, 3.14 (slightly like) for aroma, 3.23 (slightly like) for taste, and an overall hedonic assessment of

slightly like. These findings indicate that optimization of blanching time has potential practical application in the herbal tea industry to produce avocado leaf tea with improved functional properties and acceptable sensory quality. Further studies are recommended to evaluate different drying methods to improve sensory quality and antioxidant stability.

To improve industrial environmental health quality sustainably, several strategic steps are recommended:

1. Strengthening internal environmental audits and periodic health examinations.
2. Gradual adoption of environmentally friendly technologies.
3. Continuous training and education on industrial hygiene and emergency response.
4. Active collaboration with environmental authorities and surrounding communities through transparent environmental monitoring.

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