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A Legal-Economic Analysis of Industrial Compliance in Waste Management Hazardous Chemicals and Estimating the Social Costs of Regulatory Non-Compliance

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Abstract

This study aims to analyze industry compliance in the management of hazardous chemical waste from an economic law perspective and to examine estimates of the social costs resulting from regulatory noncompliance. This paper adopts a qualitative method using a literature review approach through the analysis of scientific literature and relevant regulations. The results of the study indicate that although Indonesia has fairly adequate regulations for the management of hazardous chemical waste, the level of industry compliance is still influenced by economic considerations, particularly the comparison between compliance costs and the risk of sanctions. Industrial non-compliance generates negative externalities in the form of environmental pollution and increased social costs borne by the public. Therefore, strengthened law enforcement, effective oversight, and the implementation of more transparent environmental accounting are necessary to reduce the social costs resulting from regulatory non-compliance.

Keywords: Economic Law, Hazardous Waste, Industrial Compliance, Social Costs, Environmental Regulations

INTRODUCTION

Indonesia, the industrial sector is one of the primary drivers of the national economic framework, making a substantial contribution to the country. This is reflected in the high demand for industrial products and the significant level of labor absorption within the industrial sector (Nurhayati et al., 2025). However, high demand does not always produce ideal outcomes. Significant consequences often accompany the increasing demand for industrial products, one of which is the generation of industrial waste that has the potential to become an environmental pollutant if not properly managed.

From the perspective of existing regulations in Indonesia, the government has in fact established legal provisions regarding waste management procedures, as stipulated in Law Number 32 of 2009 concerning Environmental Protection and Management. The law emphasizes that every business actor, including both owners and operators, is obligated to participate in maintaining the environmental sustainability of their business areas and to control or minimize the environmental impacts arising from their activities. Nevertheless, the existence of such regulations does not automatically guarantee a high level of compliance among industrial business actors.

From an economic perspective, law is regarded as one of the components that influence individual behavior through economic incentives, whereby actors tend to choose actions that minimize costs and maximize profits. Accordingly, when the cost of compliance with waste management obligations (compliance cost) exceeds the potential sanctions imposed, industries are more likely to neglect such obligations (Adiyanta & Widyastuti, 2021). This condition gives rise to what is referred to as social cost, namely the total losses borne by society as a result of uncontrolled economic activities. These social costs are often far greater than the expenses that industries should incur to properly manage their waste. This situation indicates a failure in both the design and implementation of regulations, particularly when the sanctions imposed are insufficient to create a deterrent effect for business actors (Vibriyanto et al., 2025).

This phenomenon can be observed in various environmental pollution cases in Indonesia, where industries discharge chemical waste directly into water bodies without adequate treatment processes. The impacts of such actions are not only manifested in environmental degradation, but also generate broader economic losses for society, including rising healthcare costs, declining productivity, and the loss of livelihoods. In environmental economics, this condition is known as a negative externality, namely a situation in which the costs arising from an economic activity are not borne by the responsible actor, but instead transferred to other parties. As a result, a discrepancy emerges between private costs and social costs, thereby necessitating policy intervention to correct the imbalance (Hutajulu et al., 2026).

Based on these conditions, this research becomes important in order to examine more comprehensively the relationship between law, industrial economic behavior, and the resulting social impacts. A law and economics approach is necessary to understand the extent to which existing regulations are capable of creating effective incentives for industrial compliance, while also measuring the magnitude of social losses caused by such non-compliance. Therefore, the findings of this research are expected to contribute to the formulation of policies that are more efficient, equitable, and sustainability-oriented.

METHOD

This paper was written using a qualitative method with a literature review approach. Qualitative research was chosen because it aims to describe and analyze industrial non-compliance in the management of hazardous chemical waste and the social costs associated with such non-compliance. This article employs a literature review technique to identify and compile scientific literature sources that can be used to address the issues discussed in this paper.

RESULTS AND DISCUSSION

Criteria for Hazardous Chemical Substances

The use of hazardous chemicals in modern industry has become a common practice to support various production and operational activities. These chemical substances are frequently utilized to improve process efficiency, enhance the quality of manufactured products, and encourage the development of technological innovation. Nevertheless, behind these various benefits, the utilization of hazardous chemicals also poses considerable health risks, particularly for workers who are directly or indirectly exposed during work processes (Rahmadani & Syafri, 2024).

Industries that utilize chemical substances in their production processes involve various activities containing hazardous risks. One example is subsea pipeline leakage, which may occur due to material degradation such as corrosion, seawater erosion, aging pipelines, or design failures. In addition, hydrocarbon leaks may create serious risks because they can trigger fires, explosions, and thermal radiation, similar to toxic gas leaks such as H_2S, which are dangerous to the health and safety of workers. Other potential risks include blowouts during drilling operations, accidents involving workers falling into the sea in offshore oil and gas industries, as well as extreme weather conditions that may damage assets and cause injuries. Furthermore, human error also constitutes an important risk factor, including the possibility of spills involving other chemical substances that are flammable, toxic, hazardous, and even carcinogenic (Nurcantika et al., 2025).

Each chemical substance possesses different levels of hazard and risk depending on its properties and characteristics. In general, the potential hazards of chemical substances may be classified into several categories, namely hazards to human health (health hazards), hazards associated with the potential for fire (fire hazards), hazards related to reactivity with water or other substances (reactivity hazards), and other special hazards (special hazards) (Fakruddin, 2025). In industrial activities, chemical substances with hazardous characteristics have the potential to generate waste. One type of waste produced by the industrial sector is hazardous and toxic waste, commonly referred to as B3 waste (Luthfi et al., 2025).

B3 waste refers to residual waste generated from a business and/or activity which, due to its nature, concentration, and quantity, contains hazardous and toxic substances. Such substances have the potential to cause environmental pollution and produce negative impacts on human health, both directly and indirectly, while also threatening the survival of other living organisms (Berliana et al., 2023). The management of B3 waste has become an important issue requiring serious attention from various stakeholders, including the government, business actors, and the public. In Indonesia, B3 waste management is regulated under Law Number 32 of 2009 concerning Environmental Protection and Management, as well as Government Regulation Number 101 of 2014 concerning the Management of Hazardous and Toxic Waste. Based on these regulations, every business entity that generates B3 waste is obligated to manage it safely and responsibly (Yuniar et al., 2024).

According to Government Regulation Number 18 of 1999 concerning the Management of Hazardous and Toxic Waste, the sources of B3 waste are classified into several categories. First, B3 waste originating from non-specific sources, namely waste generally generated from equipment maintenance activities rather than from core production processes, such as corrosion protection materials, lime scale, and residual solvents from packaging. Second, B3 waste originating from specific sources, namely waste derived from industrial residues or activities that can be clearly identified. In addition, B3 waste also includes products that fail to meet product specifications, such as expired chemicals, liquid spills, used packaging, and residual products that can no longer be reused. When a waste material can no longer be utilized, it is categorized as B3 waste and requires management and disposal in accordance with applicable regulations (Gustav et al., 2024).

Industrial Compliance in Hazardous Chemical Waste Management

can be understood that Indonesia has established a relatively clear legal framework governing the management of hazardous and toxic waste (B3 waste). These regulations are stipulated in Law Number 32 of 2009 concerning Environmental Protection and Management, as well as Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The regulations provide that every business actor generating B3 waste is obligated to manage such waste through several stages, including storage, transportation, utilization, treatment, and final disposal, in accordance with environmental standards established by the government. Furthermore, B3 waste management activities must obtain permits from the government and remain under the supervision of environmental authorities in order to prevent environmental pollution.

These provisions demonstrate that environmental regulations in Indonesia have adopted the polluter pays principle, namely the principle asserting that parties responsible for generating pollution or waste must bear the costs of waste

management and environmental restoration. This principle constitutes an important foundation in modern environmental law because it aims to ensure that the costs of environmental damage are not transferred to society at large, but instead remain the responsibility of business actors conducting production activities (Nugroho et al., 2024). Therefore, the obligation to manage B3 waste as regulated by law is not merely administrative in nature, but also represents a form of legal and economic responsibility of companies toward the environmental impacts resulting from their activities.

Although these regulations have provided a relatively clear legal basis, the level of industrial compliance with hazardous chemical waste management in practice still varies considerably. Several studies indicate that large-scale companies generally demonstrate higher levels of compliance because they possess greater access to waste treatment technologies and more advanced environmental management systems. In contrast, small and medium-sized industries often face resource limitations, preventing them from fully complying with established waste management standards (Wube Dametew, 2015). This condition indicates that the implementation of environmental regulations is influenced not only by the existence of legal rules, but also by the capacity and economic capability of companies to fulfill such obligations.

From the perspective of law and economics, industrial compliance with environmental regulations is closely related to the cost structure borne by companies. Hazardous chemical waste management requires substantial investment, including the construction of waste treatment facilities, the use of pollution control technologies, and continuous operational expenditures. Under certain conditions, companies may perceive these costs as an additional burden on production activities, such that decisions regarding regulatory compliance are often influenced by a comparison between compliance costs and the potential sanctions that may be imposed by the government (Yonnawati, 2022).

Within the framework of Law and Economics theory, Isyunanda (2022) explains that the level of compliance with legal regulations is strongly influenced by the probability of detecting violations as well as the severity of sanctions imposed. If the risk of sanctions imposed by the government is relatively low compared to the costs required for proper waste management, some companies may choose not to fully comply with such regulations. Research conducted by Prasetyaningsih et al. (2022) further demonstrates that the level of corporate compliance with environmental regulations is significantly influenced by the effectiveness of law enforcement and the intensity of governmental supervision.

The effectiveness of government oversight constitutes a crucial factor in ensuring that environmental regulations are implemented optimally. Consistent supervision and the strict enforcement of sanctions may increase corporate compliance because violations of environmental regulations would create greater legal risks. Conversely, if supervision remains weak or law enforcement is not implemented effectively, business actors may perceive violations of environmental regulations as carrying insignificant consequences. This is consistent with the view expressed by Dazagbyilo et al. (2025), who argue that the success of environmental regulations is strongly influenced by the combination of clear legal rules and effective law enforcement mechanisms.

In the Indonesian context, several environmental pollution cases involving industrial waste indicate that violations relating to B3 waste management still occur, suggesting that the implementation of environmental regulations has not yet been fully effective. This condition reflects the existence of a gap between the legal rules that have been established and the actual implementation of waste management practices in the field.

Non-compliance in the management of hazardous chemical waste may also generate extensive impacts on both the environment and society. The disposal of industrial waste that fails to meet regulatory standards has the potential to cause pollution of water, soil, and air, which ultimately affects the health of communities surrounding industrial areas. From the perspective of environmental economics, this condition is referred to as an externality, namely a negative impact arising from production activities that is not fully borne by the company, but instead shared by society at large (Berliantari et al., 2024). These impacts create social costs that must be borne by society and the government, particularly in the form of environmental restoration costs and public health expenditures.

Based on this analysis, it can be understood that the level of industrial compliance in the management of hazardous chemical waste, from a law and economics perspective, is influenced by several major factors, namely the magnitude of compliance costs borne by companies, the effectiveness of government oversight, and the severity of sanctions imposed under environmental regulations. Therefore, although Indonesia already possesses relatively clear regulations regarding B3 waste management, the level of industrial compliance in practice remains heavily influenced by the structure of economic incentives faced by business actors.

Estimation of Social Costs Resulting from Regulatory Non-Compliance

The development of economic activities today, particularly in the industrial and manufacturing sectors, is often accompanied by increasing pressure on the surrounding environment. Production processes that continuously utilize natural resources have the potential to generate various external impacts such as air, water, and soil pollution. These effects are not always reflected in the production costs borne by companies, resulting in a portion of the economic losses being transferred to society and the environment. From an economic perspective, this phenomenon is referred to as social cost.

In the study of environmental management accounting, the measurement of costs associated with environmental impacts constitutes an important component in evaluating corporate responsibility for production activities. According to Hansen and Mowen (2008), environmental costs refer to all costs arising from corporate activities related to the prevention, control, and mitigation of environmental impacts generated by production processes.

Hansen and Mowen (2008:413) classify environmental costs into four categories, as follows:

1. *Environmental prevention costs*, namely costs incurred to prevent environmental pollution or waste. These costs are associated with activities aimed at reducing the possibility of environmental damage before it occurs.

2. *Environmental detection costs*, namely costs incurred to determine whether products, processes, and other company activities comply with applicable environmental standards.
3. *Environmental internal failure costs*, namely costs arising because waste or pollution has been generated but is still managed internally within the company before being released into the external environment.
4. *Environmental external failure costs*, namely costs arising because waste or pollution has been discharged into the environment and has caused impacts outside the company, thereby requiring the company to bear the costs resulting from such environmental damage.

The estimation of social costs arising from non-compliance with regulations is important not only in relation to measuring economic impacts, but also in relation to corporate failure to internalize the negative impacts generated by its activities. In this context, social costs are viewed not merely as the total losses suffered by the environment and society, but also as an indication of inefficient resource allocation caused by regulatory non-compliance. Therefore, high social costs demonstrate the existence of a discrepancy between the costs borne by companies and those borne by society.

Conceptually, the estimation of social costs originates from environmental costs. The problem arises from the tendency of companies to recognize only internal costs, while external failure costs are often not adequately recorded. As a result, financial statements do not fully reflect the actual economic impacts of corporate activities. This condition reinforces the argument that, in the absence of appropriate regulations, companies tend to transfer a portion of their costs to society, thereby increasing overall social costs.

Environmental accounting disclosures discussed by Nuraeni et al. (2025) indicate that transparency may improve corporate financial performance. However, transparency does not always correspond with accountability. Disclosures that are merely formalistic or lack standardization have the potential to create information asymmetry, thereby preventing stakeholders from accurately assessing the magnitude of social costs generated by companies. This condition demonstrates that stricter reporting standards are required to ensure that disclosed information genuinely reflects actual conditions.

Cost accounting also contributes to identifying sources of inefficiency and the management of production waste. Nevertheless, this approach still possesses limitations if it is not integrated with a comprehensive environmental accounting framework. Cost accounting tends to focus primarily on internal efficiency and therefore is not fully capable of capturing external costs, which constitute the core component of social costs. Consequently, further integration between cost accounting and environmental accounting is required in order to produce more accurate estimates of social costs.

Although there is a relationship between environmental costs, corporate performance, and regulations, gaps still exist in comprehensively internalizing social costs. Regulatory non-compliance remains a major factor contributing to high social costs, particularly when corporate mechanisms and regulatory systems are not functioning optimally. Therefore, the estimation of social costs serves not only as a measurement tool, but also as an indicator of systemic failure requiring improvement through policy approaches, enhanced transparency, and the integration of more comprehensive accounting systems.

The estimation of social costs arising from non-compliance with environmental regulations cannot be separated from the legal framework applicable in Indonesia. Environmental management is regulated under Law Number 32 of 2009 concerning Environmental Protection and Management, which emphasizes that every business activity is obligated to preserve environmental sustainability and prevent environmental pollution and degradation. This law also incorporates the polluter pays principle, whereby parties responsible for pollution are required to bear the costs of environmental restoration. One important provision is Article 69 paragraph (1), which prohibits any individual or entity from engaging in actions that result in environmental pollution and/or environmental damage. Violations of this provision have direct implications for the emergence of negative externalities, which constitute a major component of social costs.

Through Law Number 11 of 2020 concerning Job Creation, the government sought to simplify business licensing procedures, including those related to environmental aspects. Although the policy aims to increase investment, it has also attracted criticism because of its potential to weaken environmental oversight. From the perspective of social costs, regulatory relaxation without being accompanied by strict supervision may increase the risk of non-compliance, thereby enlarging the potential social costs borne by society. Environmental law enforcement mechanisms in Indonesia include administrative, civil, and criminal sanctions. The existence of these sanctions is expected to create a deterrent effect for business actors. However, in practice, the effectiveness of such sanctions is often influenced by institutional factors such as supervisory capacity, transparency, and consistency in law enforcement.

From the perspective of law and economics, this condition indicates a failure to create appropriate incentives for companies to comply with applicable regulations. Ideally, the magnitude of sanctions and environmental restoration costs should exceed the benefits obtained from regulatory non-compliance. Maharani & Sisdianto (2025) found that government regulations influence the implementation of environmental accounting, which in turn may enhance corporate transparency and accountability. Through improved implementation of environmental accounting, the potential for social costs may be identified and controlled more systematically.

The legal framework in Indonesia has provided a strong foundation for regulating corporate environmental responsibility. Nevertheless, the principal challenge lies in the implementation and enforcement of laws that have not yet operated optimally. In relation to the estimation of social costs, law should function not merely as an instrument of control, but also as a mechanism to ensure that all external costs are internalized by companies. Therefore, strengthening regulations, enhancing supervision, and integrating environmental accounting systems constitute important measures in reducing social costs arising from regulatory non-compliance

CONCLUSION

Based on the results of the discussion, it can be concluded that the level of industry compliance in the management of hazardous chemical waste is still influenced by economic considerations, particularly the comparison between compliance costs and the risk of penalties imposed. Although Indonesia already has fairly adequate regulations regarding the management of hazardous chemical waste, the effectiveness of their implementation still depends on consistent monitoring and law enforcement. Industrial non-compliance with environmental regulations results in negative externalities in the form of social costs borne by the community and the environment. Therefore, it is necessary to strengthen law enforcement, improve oversight, and implement more transparent environmental accounting to reduce social costs and improve industrial compliance with hazardous waste management.

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