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NEGATIVE EXTERNALITIES AND MARKET FAILURES: A CASE STUDY OF INDUSTRIAL WASTE POLLUTION AND THE URGENCY OF GOVERNMENT INTERVENTION

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ABSTRACT

Profit-oriented industrial production activities frequently disregard the social costs imposed on communities and surrounding environments, resulting in negative externalities manifested as industrial waste pollution discharged into river bodies. This study aims to analyze the mechanisms of market failure caused by negative externalities, identify the multidimensional impacts of industrial waste pollution on community welfare, and formulate the urgency of government intervention through appropriate policy instruments. The method employed is a descriptive qualitative case study combined with a systematic review of welfare economics literature, externality theory, and environmental regulatory frameworks. The analysis results indicate that industrial waste pollution causes a drastic deterioration in river water quality, public health disturbances, economic losses for fishermen and affected residents, and an increased household expenditure burden. Market failure occurs because the free market price mechanism fails to internalize social costs into product prices, resulting in inefficient resource allocation and overproduction. The conclusion affirms that government intervention through environmental regulation, Pigouvian taxation, periodic monitoring systems, and strict sanctions are absolute prerequisites for achieving a balance between economic growth and environmental sustainability.

Keywords: Negative Externalities, Market Failure, Pigouvian Tax, Industrial Waste Pollution, Government Intervention

INTRODUCTION

The problem of environmental pollution due to industrial activities has developed into one of the most pressing challenges in global economic governance in the 21st century. Data from the United Nations Environment Programme (UNEP, 2022) reveals that around 80 percent of all industrial and household wastewater in the world is discharged into the environment without adequate treatment processes, and this condition is most severe in developing countries in South Asia, Sub-Saharan Africa, and Southeast Asia. The World Health Organization (WHO, 2023) report adds that water pollution causes the deaths of more than 1.4 million people per year globally, with the majority of victims coming from vulnerable groups such as children, the elderly, and low-income people living around industrial estates. In developed countries such as Germany, Japan, and the Netherlands, similar problems occurred in the industrialization era in the early 20th century, but were successfully overcome through the implementation of strict environmental regulations and effective internalization mechanisms of social costs (OECD, 2021). This stark contrast between environmental management in developed and developing countries reflects fundamental differences in institutional capacity and political commitment to sustainability principles. This condition invites serious attention from economists, policymakers, and academics to examine more deeply the mechanisms of market failure underlying the issue of negative externalities of the industry. This research comes as an academic response to this need, by presenting a comprehensive analysis that integrates welfare economics theory, empirical case studies, and evidence-based policy recommendations.

At the national level, Indonesia is facing an increasingly worrying river pollution crisis in line with the rapid expansion of manufacturing, textile, and food processing industrial estates over the past decade. The Ministry of Environment and Forestry of the Republic of Indonesia (MoEF, 2023) noted that of the 33 major rivers evaluated nationally, as many as 29 rivers or around 87.9 percent are classified as severely to severely polluted due to the disposal of industrial waste that does not meet environmental quality standards. The results of

the 2022 National River Water Quality Monitoring show that the parameters of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS) in a number of strategic rivers such as the Citarum, Ciliwung, and Bengawan Solo rivers have exceeded the threshold set by Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management (Central Statistics Agency, 2023). Economic losses due to water quality degradation in Indonesia are estimated to reach Rp 34.3 trillion per year, including health costs, decreased fishermen's productivity, and loss of ecological tourism potential (World Bank, 2021). A study conducted by Pratiwi and Kurniawan (2022) found that people living within a radius of 3 kilometers of industrial estates that pollute rivers have a 2.7 times higher risk of health problems than the control group. This phenomenon shows that the social costs of industrial pollution are not only ecological, but also have direct implications for human capital and long-term economic productivity (Hidayat et al., 2021). The complexity of this problem requires an analytical approach that not only touches the technical aspects of waste management, but also touches the root of the problem in the political economy framework of environmental regulation.

Theoretically, the problem of industrial waste pollution can be understood through the lens of the economics of externality introduced by Arthur Cecil Pigou in his work "The Economics of Welfare" (1920). Negative externalities occur when the production activities of an economic actor incur costs borne by third parties who have no involvement in the transaction, so that the marginal social cost (MSC) becomes greater than the marginal private cost (MPC). This condition results in the naturally formed market price being below the price that reflects the real social cost, thus encouraging excessive production beyond the social optimum level. This concept of market failure has been empirically confirmed by various contemporary studies, including the research of Greenstone and Jack (2015) which calculated that the environmental externalities of the industrial sector in developing countries reach an average of 6 percent of the Gross Domestic Product. In Indonesia, research by Nugroho and Santoso (2023) found that manufacturing companies that have not implemented a standard Wastewater Treatment Plant (WWTP) system on average transfer waste treatment costs of Rp 180 million per year to the community in the form of health costs and decreased productivity. This condition proves that the free market price mechanism, without proper policy corrections, is unable to allocate resources efficiently and fairly. This gap between private costs and social costs is the strongest economic justification for the presence of government intervention in organizing industrial activities.

A number of previous studies have examined specific aspects of the issue of industrial externality and market failure, but there are still analytical gaps that need to be filled by this study. Alvarez et al. (2021) in their study in Mexico found that the implementation of environmental tax-based emission regulations succeeded in reducing river pollution levels by up to 34 percent within five years, but the study did not address the impact of policy distribution on vulnerable groups. Nguyen and Pham (2022) study in Vietnam identified that weak local government oversight capacity is a key factor that exacerbates industrial pollution, but did not integrate the dimension of market failure in its analysis. At the domestic level, Rahmawati and Setiawan's (2023) research focused on the legal aspects of Indonesia's environmental regulation without linking it to the framework of externality economic theory in depth. This gap opens up space for research that integrates microeconomic perspectives, policy analysis, and empirical case studies holistically, as is the goal of this research. Emerging global trends, such as the implementation of the Carbon Border Adjustment Mechanism (CBAM) by the European Union since 2023 and the net-zero emission commitments of various countries in the Paris Agreement, further strengthen the relevance of this study in the international context (European Commission, 2023). These global regulatory dynamics also have direct implications for Indonesia's export-oriented manufacturing industry, so that improving industrial environmental governance is not only a moral obligation, but also a strategic need in maintaining national economic competitiveness.

The issue of quiet quitting, employee well-being, and the paradigm shift in corporate responsibility after the COVID-19 pandemic also enriches the context of this research from a broader socio-economic dimension. The COVID-19 pandemic that hit the world

throughout 2020-2022 has opened up global awareness about the inextricable linkages between ecosystem health, economic resilience, and human well-being (UNDP, 2021). The World Economic Forum's Global Risks Report (2023) ranks environmental policy failures and natural resource crises as two of the five biggest global risks in the perspective of the next ten years, with direct implications for macroeconomic stability. In Indonesia, the momentum of post-pandemic economic recovery, which is marked by the acceleration of the reactivation of industrial estates since 2021, has the potential to exacerbate the burden of environmental pollution if it is not accompanied by the strengthening of a proportionate supervision and law enforcement system (Setiadi & Wahyuni, 2022). The results of a survey conducted by the Indonesian Center for Environmental Law (ICEL, 2023) revealed that 67 percent of medium and large industrial companies operating in the South Tangerang area and its surroundings do not have a waste management system that meets the quality standards set by regulations. This condition reflects that the problem of negative industrial externalities in Indonesia is not only a technical problem, but also a governance and compliance problem that requires systemic and multidimensional solutions. This research is here to provide a comprehensive, contextual, and strong economic theory-based analysis as an academic contribution to the development of more effective and equitable industrial environmental policies.

Based on the background that has been presented, this study has specific and measurable objectives, namely: first, to analyze the mechanism of the occurrence of negative externalities and market failures in the context of industrial waste pollution to river bodies; second, to identify and quantify the multidimensional impact of waste pollution on environmental quality and community welfare; third, to examine the theoretical framework of government intervention that is most effective in internalizing the social costs of negative externalities; and fourth, to formulate evidence-based policy recommendations that can be applied by the central government, local governments, and industry actors in realizing sustainable and environmentally sound economic growth. The research questions asked are: What is the mechanism for market failure due to the negative externality of industrial waste pollution, and what are the most effective government policy instruments to overcome it? The significance of this research lies not only in its theoretical contribution to the development of the environmental economy, but also in its practical relevance to policy formulation that is more adaptive to the dynamics of Indonesia's evolving industrial environment. By synergistically integrating theoretical and empirical perspectives, this research is expected to be a valuable reference for academics, policy practitioners, and industry stakeholders committed to sustainable development.

RESEARCH METHODS

This study uses a qualitative descriptive case study approach combined with a systematic review of the scientific literature to produce a comprehensive, in-depth, and valid, theory-based analysis. The selection of a descriptive qualitative approach is based on the consideration that the phenomena of negative externalities and market failures are complex constructs that cannot be reduced solely to statistical figures, but rather require a holistic contextual understanding of causal mechanisms, institutional dynamics, and the multidimensional impacts they have (Creswell & Poth, 2018). The case study approach was chosen because it allows researchers to investigate phenomena in depth in their natural context, by integrating various sources of evidence such as secondary data, policy documents, international agency reports, and relevant previous research findings (Yin, 2018). The design of this study is an explanatory case study, meaning that it not only describes the existing conditions, but also explains the mechanisms and causal relationships between industrial activity, negative externalities, market failures, and government policy responses. The analytical framework used refers to Pigou's theory of externality, market failure theory, and Coase's regulatory framework as conceptual foundations that complement each other and strengthen the research arguments. This integrative approach allows the research to not only explain "what happened" but also answer "why it happened" and "how to solve it" academically and operationally.

Data collection in this study was carried out systematically through three main channels that complement each other and strengthen the validity of the findings. First, the search for secondary data from trusted international

institutions such as the United Nations Environment Programme (UNEP), the World Health Organization (WHO), the World Bank, the OECD, and the World Economic Forum published in the range of 2020 to 2025. Second, the review of relevant policy documents and laws and regulations in Indonesia, including Law Number 32 of 2009 concerning Environmental Protection and Management, Government Regulation Number 22 of 2021, as well as various derivative regulations that regulate environmental quality standards and sanction mechanisms for violators of provisions. Third, a systematic review of scientific journal articles published in the 2020-2025 period through reputable databases such as Scopus, Web of Science, and Google Scholar, using relevant keywords such as "negative externalities", "market failure", "industrial pollution", "Pigouvian tax", "environmental regulation", "river pollution Indonesia", and combinations. The literature inclusion criteria used include: (a) published in the 2020-2025 range, (b) have gone through a peer review process, (c) are relevant to the topic of externalities, market failures, or environmental policies, and (d) are available in Indonesian or English. Of the total 87 articles explored in the initial stage, 20 articles were selected as the main reference after going through a screening process based on the inclusion and exclusion criteria that have been set strictly and transparently.

Data analysis in this study was carried out through a series of stages, which are structured, systematic, and refer to the case study analysis procedures recommended by Miles et al. (2020). The first stage is data reduction, which is the process of filtering, focusing, and simplifying rough data that has been collected from various sources to identify thematic patterns relevant to the research question. The second stage is data display, which is the presentation of data in an organized and interpretable format, including impact matrices, causal diagrams, and analytical narratives that connect theoretical concepts with empirical findings in a coherent manner. The third stage is conclusion drawing and verification, which is an analytical inference process that integrates partial findings into comprehensive, consistent, and scientifically accountable conclusions. The validity of the research is maintained through triangulation of data sources, namely by comparing and confirming findings from one source to another to ensure consistency and reliability of interpretation. The principles of research ethics are also consistently upheld throughout the research process, including honesty in data reporting, respect for intellectual property rights through proper and complete citations, and transparency in reporting procedures and findings. This analytical framework is designed to produce knowledge that is not only academically valid, but also practically relevant to the development of industrial environmental policies in Indonesia.

RESULTS AND DISCUSSION

Mechanisms of Negative Externalities in Industrial Waste Pollution

The results of the analysis of the case study of industrial waste pollution show that the mechanism of negative externality comes from an asymmetrical incentive structure between producers and the communities that bear the impact. Industrial companies that dump waste directly into river bodies without adequate treatment are essentially shifting part of their production costs to external parties, so that the private costs borne by the company are much lower than the real social costs. This gap between the Marginal Private Cost (MPC) and the Marginal Social Cost (MSC) is identified in economic theory as the main source of resource allocation inefficiencies and overproduction, as elaborated in depth by Pigou (1920) and updated by Nordhaus (2021) in the context of modern environmental externalities. A study conducted by Chen et al. (2021) on 240 manufacturing companies in China found that the average waste treatment cost reached 8.3 percent of the total production cost, but companies that do not have strong regulatory obligations tend to ignore investments in WWTP systems to maximize short-term profit margins. In Indonesia, a similar condition was also found by Hidayat et al. (2021) who documented that 73 percent of small-medium industries in the Banten-Greater Jakarta industrial corridor do not have a waste treatment system that meets the standards of the Minister of Environment Regulation Number 5 of 2014. These findings confirm that negative externalities in industrial waste pollution are not isolated incidents, but rather systemic manifestations of market failures that require structural solutions. Thus, the analysis of this case study does not simply reveal a single local problem, but reflects a universal pattern that prevails in various industrial contexts in developing countries.

The impacts of industrial waste pollution identified in this case study analysis are multidimensional and interrelated in a complex chain of causality. Based on the exposure of field data and confirmation from the current literature, four main impact dimensions can be comprehensively identified. The ecological dimension includes a dramatic decline in river water quality characterized by an increased concentration of pollutant parameters such as BOD, COD, mercury, lead, and other harmful chemical compounds that permanently damage aquatic ecosystems (Rahardjo & Puspita, 2022). The public health dimension includes an increased incidence of skin diseases, respiratory disorders, chronic diarrhea, and long-term cancer risk due to exposure to polluted water used for daily domestic purposes (WHO, 2023). The economic dimension includes direct losses to traditional fishers and residents who depend on water resources for their livelihoods, as well as the additional burden of clean water purchases that burden low-income households (Setiadi & Wahyuni, 2022). The socio-cultural dimension is the erosion of social capital and public trust in governments and industry actors, which can worsen social cohesion and hinder sustainable development in affected areas. The interconnectedness between these four impact dimensions creates a cycle of environmental poverty that is difficult to break without systemic intervention from all relevant stakeholders.

Table 1. Multidimensional Impact Matrix of Industrial Waste Pollution on Community Welfare

No.	Impact Dimension	Loss Indicators	Severity (1–5)	Remarks
A	Ecological	Deterioration of River Water Quality (BOD, COD, TSS Increased)	5	Very Bad
B	Health	Public Health Disorders (Itching, Irritation, Diarrhea)	4	Weight
C	Economy	Loss of Fishermen & Affected Residents (Decrease in Income)	5	Very High
D	Social	Increase in Household Expenditure (Purchase of Clean Water)	4	Significant
E	Regulation	Non-compliance with Environmental Quality Standards	4	Worrying

Scale: 5 = Very Heavy; 4 = Heavy; 3 = Moderate; 2 = Lightweight; 1 = Very Light

Analysis of Market Failures and Justifications for Government Intervention

Market failure in the context of industrial waste pollution can be understood through two complementary analytical frameworks, namely the Pigouvian framework that emphasizes the role of tax correction, and the Coasian framework that emphasizes the importance of property rights that are clearly defined as alternative solutions. In the Pigouvian framework, market failure occurs because the divergence between private costs and social costs causes the market equilibrium price to be below the social optimum price, so that the output produced exceeds the socially efficient level (Nordhaus, 2021). The correction to this failure can be made through the imposition of a tax equal to the negative externality value at the optimal output level, known as the Pigouvian tax, so that companies are encouraged to internalize social costs into their production decisions. Research by Gao et al. (2022) conducted in China found that the implementation of the Environmental Protection Tax since 2018 has succeeded in reducing industrial pollutant emissions by an average of 18.2 percent in the first three years of its implementation, proving the effectiveness of fiscal instruments in correcting negative externalities. On the other hand, Coase's theorem offers the perspective that if resource ownership rights are clearly defined and transaction costs can be ignored, then private negotiations between industry players and affected communities can produce Pareto-efficient solutions without the need for government intervention (Coase, 1960). However, in real practice in developing countries, including Indonesia, the conditions required by Coase's theorem are rarely met due to high transaction costs, an imbalance of bargaining power between industry and society, and legal

uncertainty about natural resource ownership rights. Thus, government intervention through regulations and fiscal instruments remains the most realistic and effective solution in the current Indonesian context.

A review of various policy instruments that governments can use to correct negative externalities shows that there is no single solution that is most effective for all contexts, but rather a policy mix that is tailored to the characteristics of the industry, the institutional capacity of the government, and the socio-economic conditions of the local community. Direct regulatory instruments (command-and-control) such as the setting of emission standards, the obligation to have a certified WWTP, and strict environmental licensing are the most basic foundations of an effective industrial environmental governance system. Research by Alvarez et al. (2021) in Mexico showed that the combination of emission standard regulation and periodic environmental audit systems succeeded in reducing river pollution by 34 percent in five years, with the most significant effect on the textile and food processing industries. Economic instruments such as environmental taxes (Pigouvian tax), cap-and-trade trading schemes, and environmentally friendly technology subsidies offer greater flexibility to industry players in choosing the most cost-effective way to meet set environmental targets (Goulder & Parry, 2021). Findings from Nugroho and Santoso (2023) in Indonesia show that providing fiscal incentives in the form of tax breaks for companies investing in waste treatment technology has succeeded in increasing environmental compliance rates by 27 percent among medium-sized industries. Technology-based information and monitoring systems, such as real-time water quality monitoring using IoT sensors connected to government dashboards, have also been shown to dramatically increase the effectiveness of environmental law enforcement (Gunawan et al., 2023). A policy mix that integrates these three approaches of regulation, economic incentives, and surveillance technology is the most promising strategy to address the negative externalities of industries in Indonesia in a comprehensive and sustainable manner.

The dimension of distributive justice is an aspect that is often overlooked in environmental policy discussions, but it is crucial to ensure that the cost burden of external correction is not disproportionately imposed on the most vulnerable groups of society. A study by Cahya and Permatasari (2023) in the Tangerang industrial estate shows that low-income people living around industrial estates bear a significantly heavier pollution burden than middle- and high-income groups, due to limited access to alternative clean water and adequate health facilities. This phenomenon is known in the academic literature as the "environmental justice gap", which is the gap between who benefits economically from industrial activities and who bears the environmental costs. Environmental policies designed without considering this dimension of justice risk creating social injustices that actually exacerbate existing inequalities. Therefore, Setiadi and Wahyuni (2022) recommend that any industrial environmental policy in Indonesia must be accompanied by a transparent compensation mechanism for affected communities, as well as economic empowerment programs that help affected residents to build alternative sources of livelihood. This recommendation is in line with the principles of sustainable development which affirm that economic growth, environmental sustainability, and social justice are three pillars that cannot be separated from each other. The integration of distributive justice perspectives into the industrial environmental policy framework is not only an ethical obligation, but also a political prerequisite for the successful implementation of such policies in the long term.

The prospect of strengthening industrial environmental governance in Indonesia needs to be studied in the context of the digital transformation agenda and sustainable development commitments that are being carried out by the government through various national strategic programs. The implementation of a digital technology-based water quality monitoring system, the integration of environmental data into a nationally integrated Environmental Information System (SILH), and the use of artificial intelligence for the early detection of environmental violations are promising policy innovations and have begun to be implemented gradually. Research by Gunawan et al. (2023) shows that the use of online water quality sensors installed at strategic points of rivers in industrial estates is able to increase the speed of violation detection from an average of 14 days to less than 24 hours, thereby dramatically increasing the effectiveness of environmental law enforcement. At the global level, the Carbon Border Adjustment Mechanism

(CBAM) implemented by the European Union since October 2023 provides additional market pressure for Indonesian industries to immediately improve their environmental management standards so that export products do not be displaced from the European market due to not meeting the set carbon standards (European Commission, 2023). This increasingly stringent international sustainability framework, combined with increasing global consumer awareness of the environmental footprint of the products they purchase, provides an increasingly strong market incentive for Indonesian industries to transform towards more environmentally friendly production practices. Therefore, the agenda to strengthen industrial environmental governance should not be seen as a regulatory burden that hinders growth, but rather as a long-term strategic investment that will increase Indonesia's economic competitiveness on the global stage that is increasingly environmentally conscious.

CONCLUSION

This study successfully confirms that the pollution of industrial waste into river bodies is a concrete manifestation of market failure that stems from negative externalities, i.e. conditions in which the social costs of production activities far exceed the private costs borne by companies. This divergence between private costs and social costs creates a distorted incentive for industry players to continue producing at levels that exceed the social optimal, while shifting their environmental costs to communities that do not have adequate protection mechanisms. The multidimensional impacts identified, including ecological, health, economic, and socio-cultural dimensions, prove that this problem cannot be solved through a partial sectoral approach, but requires a holistic and integrated policy response. The most effective instruments of government intervention are a policy mix that combines direct regulation in the form of emission standards and WWTP obligations, economic instruments in the form of Pigouvian taxes and fiscal incentives, and digital technology-based monitoring systems that allow for early detection of violations. The relevance of this research is further strengthened by the dynamics of global environmental regulations, including the implementation of CBAM by the European Union and various international climate commitments, which provide additional market pressure for Indonesian industries to immediately improve their environmental management standards. As a practical recommendation, the government needs to strengthen the monitoring capacity of environmental agencies at the regional level, increase the transparency of publicly accessible environmental quality data, and develop a fair and transparent compensation mechanism for people who have borne the brunt of pollution. True and sustainable economic development can only be realized if all social costs of production are honestly internalized into the prevailing price system, so as to create a fair balance between economic growth, social welfare, and environmental sustainability.

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