WASS
Waste, Society and Sustainability
WASS 3(1): 143–158
ISSN 3062-8202

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

Foreign direct investment and the waste paradox: When environmental governance lags behind economic growth

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Received Date: November 13, 2025 Revised Date: February 10, 2026 Accepted Date: February 25, 2026

ABSTRACT

Background: Economic growth is a primary objective for many countries, including Indonesia. Foreign direct investment (FDI) plays a significant role in driving this growth. However, focusing solely on economic expansion may overlook potential environmental consequences caused by uncontrolled foreign investment. This paper examines how FDI impacts the hazardous and toxic waste management ratio. **Methods:** The data were analyzed using descriptive and comparative methods to identify trends, correlations, and variations between FDI realization and key environmental indicators. The descriptive analysis summarizes data using tables, line charts, and ratios to clearly illustrate changes over time. To guide the analysis, this study adopts Miles and Huberman's Interactive Model, providing a flexible yet systematic framework for qualitative data interpretation. **Findings:** The analysis reveals that rapid industrialization, particularly in the manufacturing sector, generates substantial hazardous and toxic waste that often exceeds current treatment capacity. Comparative data show that regions with higher FDI inflows correspond to higher waste generation, highlighting gaps in infrastructure, governance, and regulatory enforcement. While some companies have adopted cleaner technologies, the overall B3 management ratio remains insufficient, indicating structural weaknesses in environmental oversight. These findings underscore the need for policies that align economic growth with environmental protection, including stricter monitoring, capacity building, and promotion of green FDI. **Conclusion:** While FDI has boosted industrial expansion, technology transfer, and employment, hazardous waste management has lagged behind. This gap underscores the importance of integrating environmental sustainability into FDI planning and industrial policy. **Novelty/Originality of this article:** This study examines the relationship between inward FDI and hazardous and toxic waste (B3) management ratio, emphasizing the urgent need for greener FDI in Indonesia.

KEYWORDS: foreign direct investment; green investment; hazardous and toxic waste management.

1. Introduction

Foreign Direct Investment (FDI) is an investment made by an entity from one country into a company located in another country, where the investor holds significant influence or control over the company (OECD, 2025). FDI plays an important role in fostering economic development, as it facilitates capital inflows, technology transfer, and the creation of employment opportunities in the host country (Pandey et al., 2021). FDI has several forms, such as mergers and acquisitions, share purchases, or the acquisition of specific assets (Otto, 2020). Through these forms, foreign investors are able to participate directly in the management and decision-making processes of domestic enterprises, thereby

Cite This Article:
Qathrunnada, A. R. (2026). Foreign direct investment and the waste paradox: When environmental governance lags behind economic growth. *Waste, Society and Sustainability*, *3*(1), 143-158. https://doi.org/10.61511/wass.v3i1.2026.2801

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influencing their productivity, competitiveness, and integration into the global market. Consequently, the presence of FDI not only improves industrial efficiency but also strengthens economic connections between domestic and international markets.

FDI is a key driver of economic growth in countries, particularly in developing nations like Indonesia, where vast potential and available land make it suitable for foreign investors to establish their capital (Lee et al., 2024). In Indonesia, FDI has a significant positive impact on the economic cycle, particularly in several provinces with strong potential to attract such investment (Fazaalloh, 2024). The presence of multinational corporations (MNEs) in these regions often contributes to regional development, job creation, and the transfer of technology, creating spillover effects that enhance local economic resilience. Empirical studies have shown that FDI inflows are closely associated with infrastructure development, innovation diffusion, and skill upgrading among domestic firms, particularly within industrial clusters (Ali et al., 2023).

FDI offers several benefits for the host country, as improvements in a nation's economic index exert a statistically significant and positive influence on FDI across countries at different stages of development (Lee et al., 2024). This two-way relationship indicates that FDI not only responds to but also stimulates economic stability and institutional progress within host economies. The multiplier effect generated by FDI thus extends beyond mere capital accumulation; it can influence policy reforms, human capital formation, and regional economic balance (Chrystella et al., 2025).

However, while FDI supports economic growth, it can also create challenges, especially related to environmental damage and sustainability (Famanta et al., 2024). Previous research also found that FDI inflows contribute to rising CO_2 emissions in developing countries (Sarkodie & Strezov, 2018). Furthermore, FDI has been linked to higher levels of pollution in Indonesia (Bachri & Normelani, 2020). These findings indicate that certain FDI activities may not incorporate environmentally sustainable practices in their operations, which could lead to long-term environmental degradation and undermine broader environmental objectives and sustainability efforts. Such impacts may further affect various aspects of the ecosystem, including air, water, and soil quality (Hanh et al., 2020). This phenomenon reflects what scholars have termed the "pollution haven hypothesis," in which developing countries become destinations for environmentally intensive industries from developed economies (Cole & Elliott, 2005). Under weak regulatory oversight, such investments may prioritize profit efficiency over ecological protection. Yet, a contrasting perspective on the "pollution halo hypothesis" argues that FDI can also transfer cleaner technologies and managerial know-how, promoting greener production systems in host countries. These opposing views underscore that the environmental outcomes of FDI are not uniform but depend heavily on the quality of governance, industrial structure, and policy enforcement in the receiving country (Akbulut & Yereli, 2023).

At the same time, the global investment landscape is undergoing a transformation, with businesses increasingly prioritizing sustainability over short-term profit. This global shift toward sustainable investment is driven by heightened awareness of environmental issues, motivating companies to adopt greener strategies in their international ventures (Radhakrishnan, 2025). Investors are increasingly aware of the long-term risks associated with environmental degradation and are incorporating sustainability performance into their investment decisions. Green finance frameworks and Environmental, Social, and Governance (ESG) criteria are becoming central benchmarks in global investment flows, influencing both investor behavior and host-country policy orientation (Nhuong et al., 2024). For this reason, it has become essential for countries like Indonesia to establish clear regulatory frameworks that filter and guide incoming FDI, ensuring alignment with both economic growth objectives and environmental sustainability goals.

Over the last five years (2020-2024), FDI realization in Indonesia has been predominantly directed toward the manufacturing sector, indicating a growing number of foreign factories within the country (Ministry of Investment and Downstream Industry of Indonesia, 2024). Indonesia's strong manufacturing focus reflects its competitive labor and strategic access to Southeast Asian markets. Sectoral data show that the majority of

investments have clustered in secondary industries such as chemical production, food processing, and metal manufacturing, each contributing to higher industrial output and export performance (Ministry of Investment and Downstream Industry of Indonesia, 2024). This trend, however, also brings environmental implications, particularly when factory waste is not properly managed. Supporting this concern, data from the national records on the Management of Hazardous and Toxic (B3) Waste (Statistics Indonesia, 2024) reveal that a significant volume of such waste remains untreated, highlighting the country's ongoing challenges in maintaining sustainable industrial practices. Specifically, the proportion of managed versus generated B3 waste has fluctuated between 60%-85%, indicating inconsistent progress despite continuous investment growth. This persistent issue shows that while the economy has expanded rapidly, environmental safeguards have not kept pace with industrial development. This imbalance raises concerns about Indonesia's environmental readiness, as inefficient waste treatment may lead to soil and water contamination.

Indonesia has abundant natural resources, yet the country continues to face ongoing challenges in managing its environment responsibly. The government has introduced several environmental policies, such as the Environmental Protection and Management framework, but their implementation has not been fully effective. This limited effectiveness is closely linked to the weak legal and institutional systems that support sustainability and environmental governance. In addition, there is still little involvement from local communities and other related groups in the environmental decision-making process, which makes it harder to achieve inclusive and effective environmental management (Yustitianingtyas et al., 2025).

One example of how environmental policy is unsuccessful in filtering companies is from the mining industry, particularly the nickel sector, which has recently become a central focus as the Indonesian government seeks to enhance downstream industrialization (Rosada et al., 2023). This policy direction aims to increase the value-added of mineral exports by processing raw materials domestically; this strategy is expected to increase industrial competitiveness and state revenue. However, this industry has also become a major environmental threat, as many mining operations take place on relatively pristine islands that are home to local communities; Nickel extraction, in particular, has been linked to deforestation, water pollution, and loss of biodiversity, raising questions about the sustainability of Indonesia's resource-based FDI model (Nasution et al., 2024).

This thing is not merely the FDI fault; the government also plays a crucial role, as its regulatory decisions determine the types of FDI that are permitted to operate within the country (Furtuna & Atis, 2024). This situation highlights the growing necessity for enhanced environmental governance in Indonesia to ensure that foreign investments contribute to sustainable development objectives. With the global economy increasingly emphasizing environmental responsibility, the capacity to attract green-oriented FDI has become a critical aspect of national competitiveness. Stronger policy instruments, coupled with consistent enforcement, are needed to encourage environmentally responsible investment behavior. In this context, government institutions must not only formulate regulations but also strengthen institutional coordination among ministries handling investment, environment, and industry. The absence of integrated monitoring mechanisms often leads to fragmented enforcement, where environmental impact assessments are treated as mere administrative requirements rather than strategic sustainability tools (Boyd & Martin, 2021). By comparing the trends of FDI realization and B3 waste management ratios, this study seeks to interpret whether Indonesia's investment-driven growth aligns with environmental capacity building or exposes governance weaknesses. The findings will help identify whether economic expansion has been accompanied by sustainable industrial practices or if growth continues to occur at the expense of ecological stability. Ultimately, the analysis aims to offer insights into how Indonesia can strengthen its institutional capacity to balance economic ambition with long-term ecological resilience.

2. Methods

2.1 Research design

This research uses secondary data collected from the Ministry of Investment and Downstream Industry of Indonesia (BKPM) for the realization of Foreign Direct Investment (FDI) realization data, and environmental performance indicators in the B3 waste management are sourced from the Statistics Indonesia (BPS), specifically focusing on the generation and treatment of hazardous and toxic (B3) waste from four main sectors: agroindustry, manufacturing, mining-energy-gas, and services. The data cover the period from 2020 to 2024, representing the most recent and comprehensive timespan available for both investment and environmental indicators.

The use of secondary data is considered sufficient to identify patterns of FDI inflows in Indonesia, as it allows the researcher to capture macro-level patterns across multiple years while ensuring objectivity through the use of validated institutional data, and to evaluate the ability of companies to manage their industrial B3 waste effectively. The Ministry of Investment and Downstream Industry of Indonesia (BKPM) and Statistics Indonesia (BPS) are both nationally recognized authorities in economic and environmental statistics, ensuring that the information obtained is reliable, consistent, and representative of Indonesia's industrial and investment performance. Moreover, the utilization of secondary data reduces the time and cost of data collection while enabling the researcher to focus on in-depth analysis of trends, relationships, and policy implications. This reliance on secondary data is also consistent with qualitative-descriptive research logic, which emphasizes contextual interpretation over primary data generalization. By focusing on longitudinal and sectoral datasets, the study aims to capture the evolving interaction between investment behavior and environmental outcomes, allowing a more grounded discussion of sustainable development readiness.

In addition, the selected datasets provide a broad overview of Indonesia's industrial transformation during a period defined by post-pandemic economic recovery and expanding foreign investment activity. This timeframe is used because the period after 2020 reflects ongoing changes in industrial activities and foreign investment patterns in Indonesia, which may influence the volume of hazardous waste generation and environmental management challenges. Furthermore, the study relies on official national datasets provided by government institutions to ensure consistency and compatibility between investment and environmental indicators analyzed within the research framework.

The data were analyzed using descriptive and comparative methods to identify trends, correlations, and variations between the amount of FDI realization and key environmental indicators. The descriptive analysis involves summarizing data through tables, line charts, and ratios to present a clear picture of changes over time. Meanwhile, the comparative analysis examines sectoral differences, comparing FDI inflows and waste treatment performance. This method is particularly useful for identifying whether higher FDI inflows correlate with improved environmental management or, conversely, with increased environmental burden. Combining these approaches enhances both quantitative and qualitative interpretation, ensuring that observed fluctuations are interpreted within Indonesia's specific economic and regulatory context. The analysis enables the researcher to observe how different industrial sectors respond to increasing foreign investment while managing hazardous waste generation and treatment. By examining these sectoral patterns over multiple years, the study provides a broader understanding of the interaction between economic activity and environmental performance in Indonesia.

2.2 Data collection and analysis technique

To complement this analysis, the study introduces the B3 waste management ratio formula, which quantifies the proportion of B3 waste that has been properly treated relative

to the total amount of waste generated. This ratio serves as a key indicator of environmental performance and industrial responsibility. The formula is presented as follows:

$$B3\ Management\ Ratio = \frac{B3\ Waste\ Treated}{B3\ Waste\ Generated}\ x\ 100 \quad \text{(Eq. 1)}$$

A higher ratio indicates more effective waste management performance, reflecting stronger environmental compliance among industries and possibly a tighter government oversight. Conversely, a lower ratio may signal weaknesses in industrial waste treatment capacity, regulatory enforcement, or environmental awareness among companies. By comparing this ratio across years and sectors, this study seeks to understand whether increased FDI inflows are associated with improvements or deteriorations in waste management outcomes.

Data validity is ensured through the use of internationally recognized, government-published datasets. To minimize inconsistencies, data from multiple official sources were cross-checked and adjusted when discrepancies were identified. These adjustments ensure the final dataset remains coherent, consistent, and suitable for comparative analysis across variables. To improve data precision, the study breaks down the information into different industrial sectors. Rather than using only national totals, it examines FDI inflows by sector, covering agriculture and extraction, manufacturing and processing, and services and trade. Environmental data are also separated into categories such as agroindustry, manufacturing, mining-energy-gas, and services. This approach helps reveal how each type of industry affects the environment differently.

Finally, the chosen methodological approach aligns with the study's qualitative-descriptive design, emphasizing interpretation and contextual understanding over purely statistical correlation. The goal is not only to identify numerical trends but also to derive insights about Indonesia's environmental governance capacity and the broader implications of FDI on sustainable development. By focusing on both descriptive and interpretive dimensions, the study aims to bridge the gap between numerical evidence and policy-relevant insights. This approach recognizes that understanding the impacts of foreign investment on environmental management requires more than simple measurement; it demands consideration of institutional, regulatory, and socio-economic contexts that shape environmental outcomes. This combination of descriptive, comparative, and ratio-based analysis ensures a comprehensive, structured, and evidence-based understanding of how foreign investment interacts with environmental management in Indonesia.

During the data display stage, findings are arranged in visual or descriptive formats, such as charts comparing FDI inflows and waste management ratios, to identify emerging relationships and interpret underlying trends. These visualizations serve as analytical tools that enable patterns, anomalies, and correlations to be more easily recognized, thereby facilitating richer interpretation. The final stage, conclusion drawing and verification, integrates these insights through interpretive reflection to ensure analytical coherence and contextual depth. This stage also incorporates cross-referencing with relevant literature and theoretical frameworks, such as the Environmental Kuznets Curve, to situate the findings within a broader conceptual understanding. This approach allows the study to meaningfully connect quantitative indicators with qualitative interpretations, highlighting not only what the data show but also what they imply for policy and governance.

The calculated waste management ratio will be analyzed alongside the trend of FDI inflows in Indonesia to reveal the relationship between foreign investment and environmental management performance. If the analysis shows a decline in the waste management ratio while FDI inflows continue to increase, this indicates that Indonesia's environmental infrastructure and regulatory mechanisms may not be fully equipped to handle the environmental pressures associated with intensified investment activity. This condition may also reflect the imbalance between rapid industrial development and the availability of adequate environmental protection systems, particularly in regions

experiencing high concentrations of manufacturing and resource-based industries. In addition, insufficient investment in waste treatment facilities, limited monitoring capacity, and inconsistent implementation of environmental policies could further contribute to the decline in waste management effectiveness despite rising economic activity. Furthermore, this analysis will explore sector-specific patterns, recognizing that the environmental impact of FDI may vary across primary, secondary, and tertiary industries, each with distinct regulatory and operational challenges. Such a trend would suggest that industrial expansion is outpacing the country's capacity to manage waste effectively, thereby exposing weaknesses in institutional preparedness and environmental governance. This interpretation aligns with the Environmental Kuznets Curve (EKC) hypothesis, which suggests that environmental degradation may initially worsen with economic growth before improving once certain income and institutional thresholds are reached (Cole & Elliott, 2005).

By combining descriptive statistics, comparative trend analysis, and interpretive reflection, this methodological framework enables a holistic understanding of the FDI Inflow-FDI B3 waste management ratio nexus. It allows the study to assess whether economic openness and foreign investment are conducive to sustainable development or if they exacerbate environmental pressures. In doing so, it provides a rigorous foundation for policy recommendations aimed at strengthening environmental governance, optimizing investment strategies, and promoting sustainable industrial growth. Overall, this methodological framework, which applies Miles and Huberman's Interactive Model, allows for a nuanced assessment that goes beyond numerical correlation and instead interprets the qualitative meaning behind data patterns. It provides policymakers and researchers with empirical insights into how governance, industrial policy, and investment climate interact to shape the country's trajectory toward sustainable development.

3. Results and Discussion

This study applies a qualitative-descriptive approach guided by Miles and Huberman's Interactive Model to interpret the relationship between FDI and Hazardous and toxic waste (B3) management ratio. According to this model, the analysis proceeds cyclically through three main stages: data reduction, data display, and conclusion drawing, allowing a continuous interaction between data and interpretation. This framework emphasizes how contextual understanding can be drawn from empirical trends, making it proper for analyzing the intersection between economic and environmental indicators. Through this approach, the study seeks to explain how patterns of FDI inflows correspond with Indonesia's B3 waste management performance and what these relationships reveal about the country's institutional readiness for sustainable industrialization.

An increase in FDI inflows should ideally align with improvements in B3 waste management ratios, suggesting that foreign capital contributes to cleaner production and stronger environmental governance. However, when FDI continues to rise while waste management performance declines, it may signal that industrial expansion is outpacing environmental regulation and infrastructure, creating long-term ecological and institutional risks (Leonardo et al., 2023). The following data show FDI inflows into Indonesia from 2020 to 2024, categorized into three major sectors: primary, secondary, and tertiary. Based on data from the Ministry of Investment (BKPM), the primary sector includes forestry, fisheries, mining, food crops, plantations, and livestock activities. Meanwhile, the secondary sector consists of processing and manufacturing industries, including paper and printing, chemical and pharmaceutical industries, metal industries, food industries, and other manufacturing activities. Furthermore, the tertiary sector covers hotels and restaurants, construction, trade and repair services, transportation, warehousing, telecommunications, and various other service industries.

3.1 Trends in foreign direct investment inflow in Indonesia

Fig. 1. Presents the distribution of FDI inflows to Indonesia across the primary, secondary, and tertiary sectors during the period 2020–2024. Overall, the total FDI demonstrates a clear upward trajectory, increasing from US$28.66 billion in 2020 to US$60.01 billion in 2024. This consistent growth pattern indicates a strong and sustained investor confidence in Indonesia's economic environment over the observed period. The secondary sector dominates Indonesia's FDI structure throughout these years, showing continuous growth and representing the most attractive investment destination among the three sectors. This pattern reflects Indonesia's increasing industrial capacity and aligns with the government's strategic focus on promoting manufacturing and value-added industries to strengthen national competitiveness (Cabinet Secretariat of the Republic of Indonesia, 2025). The steady rise in investment in this sector also suggests that Indonesia has been successful in positioning itself as a regional manufacturing hub within Southeast Asia. The tertiary sector ranks second in investment share, with steady growth attributed to rising digitalization, infrastructure demand, and expansion in logistics and trade services. Meanwhile, the primary sector contributes the smallest share, and although it shows a modest increase, investor interest in extractive activities appears to be declining. This shift signals Indonesia's ongoing transition from a resource-based economy toward a more diversified and industrialized structure, emphasizing sustainable value creation.

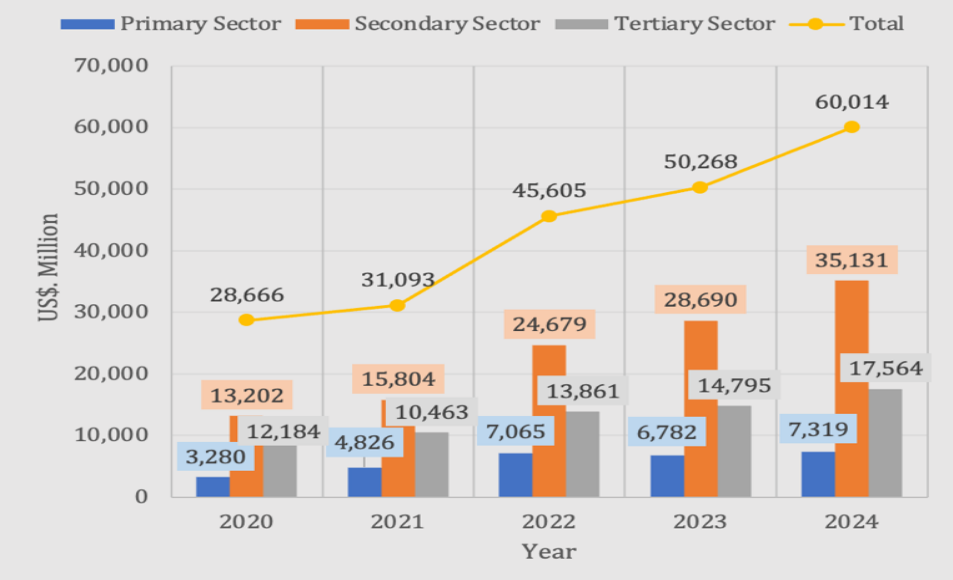

Fig. 1. Realization of FDI in Indonesia 2020–2024

Conversely, the primary sector, which includes agriculture, forestry, and mining, continues to contribute the smallest share of total FDI. Despite a slight increase between 2020 and 2024, investment in this sector remains relatively limited, suggesting a gradual decline in investor interest toward extractive industries. In summary, the data indicate that Indonesia's FDI composition is becoming increasingly industry-driven, with a growing emphasis on manufacturing and service-based sectors. The consistent increase in total FDI inflows over the five-year period highlights both the resilience of the Indonesian economy and the country's success in fostering an investment climate conducive to industrial and technological advancement.

The sectoral composition of FDI reveals a gradual decline in the primary and tertiary sectors but consistent growth in the secondary (manufacturing) sector throughout 2020-2024. This pattern suggests an economic restructuring where industrial activities dominate foreign capital inflows (Alcorta et al., 2021). Several factors may explain this trend, including government incentives for value-added manufacturing, regional supply-chain

shifts from China and Vietnam, and global investor interest in Indonesia's growing domestic market (Dang & Nguyen, 2021). Furthermore, the rising emphasis on manufacturing reflects Indonesia's strategic positioning within the global economy as a hub for production and export-oriented industries. Industrial clusters, supported by policy measures such as tax incentives, land allocation, and streamlined investment procedures, have attracted multinational corporations seeking efficient production bases and access to regional markets. This structural transformation is accompanied by technological upgrading, workforce development, and increasing integration with global value chains, which collectively strengthen Indonesia's economic resilience.

3.2 Trends in hazardous and toxic (B3) waste in Indonesia

The analysis of B3 waste management ratios across different sectors in Indonesia reveals divergent patterns that reflect both industrial activity and governance capacity. The manufacturing sector, for instance, showed improvements from 2020 to 2022; however, this progress was sharply reversed between 2022 and 2024. This decline suggests that the rapid expansion of production and the influx of new FDI may have outpaced the capacity of existing waste treatment infrastructure, a pattern consistent with findings that rapid industrialization often overwhelms environmental systems during periods of high investment (Pata & Pata, 2025). Similarly, the agroindustry sector experienced a notable drop in waste management performance between 2023 and 2024, likely due to a combination of resource depletion, limited adoption of cleaner technologies, and weak enforcement of environmental regulations in semi-rural industrial areas.

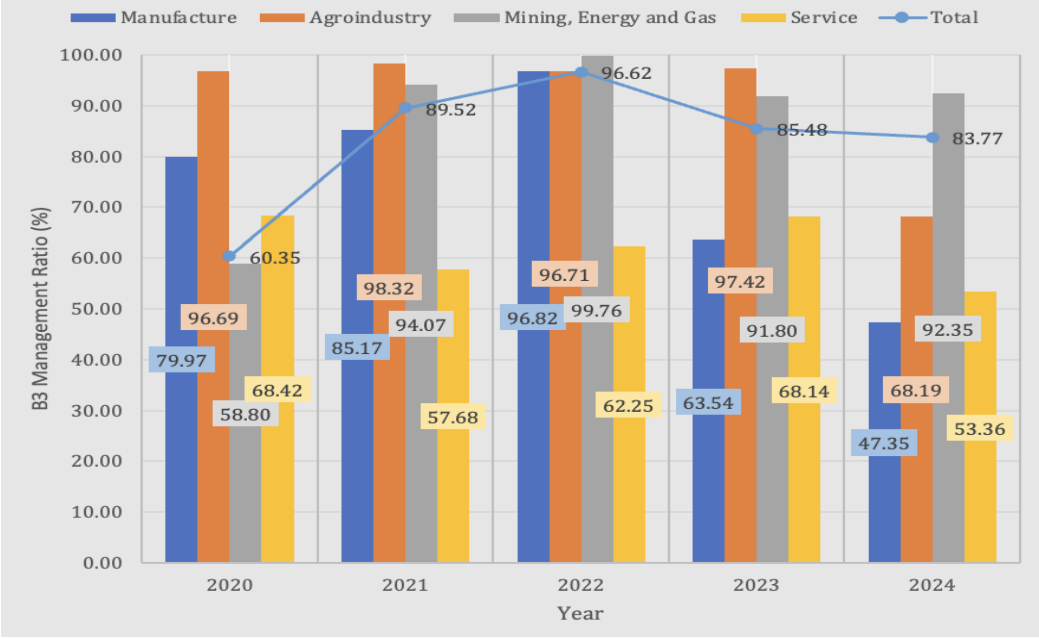

Fig. 2. Hazardous and toxic (B3) waste management ratio 2020–2024

The mining-energy-gas sector displayed more moderate fluctuations over the same period, with a dip in 2023 followed by a slight recovery in 2024. These changes may reflect incremental improvements in regulatory enforcement and monitoring within resource extraction regions. In contrast, the services sector exhibited the highest degree of volatility, experiencing a decline in 2021, a partial recovery through 2023, and another drop in 2024. This variability is likely influenced by the heterogeneous nature of service activities, where environmental regulations are often inconsistently applied, and was further compounded by operational disruptions related to the COVID-19 pandemic (Sarkodie & Owusu, 2020). Overall, these trends highlight the complex interplay between sector-specific industrial

growth, environmental infrastructure, and governance effectiveness in Indonesia's management of hazardous and toxic waste.

The decline in B3 waste management ratios after 2022, despite rising FDI, highlights Indonesia's institutional and infrastructural challenges in sustaining environmentally responsible industrialization. Several factors may explain this imbalance. First, waste treatment infrastructure in Indonesia remains unevenly distributed, with higher concentration in Java and lower capacity in outer islands such as Kalimantan and Sulawesi (Statistics Indonesia, 2024). Second, the environmental licensing and monitoring systems may not have evolved as fast as the pace of FDI entry. As more foreign investors establish operations, particularly in manufacturing zones, the volume of B3 waste grows faster than regulatory agencies can monitor or process. Third, the technological capability to treat hazardous waste remains limited, as only a few licensed facilities are capable of processing specialized waste types such as heavy metals or pharmaceutical by-products.

Another aspect worth noting is the quality, reliability, and transparency of environmental data reporting. Many industrial facilities still understate or misreport their waste generation figures, often as a way to avoid stricter regulatory monitoring or additional financial burdens related to waste treatment and disposal. This practice creates misleading perceptions of environmental performance, giving the impression of improved waste management when, in reality, treatment efforts may remain insufficient. Although Indonesia performs moderately compared to other ASEAN nations, its environmental governance capacity is still limited, resulting in weak transparency and inconsistent disclosure of environmental information (Irfan & Afrila, 2025). In addition, factors such as political stability, the rule of law, and the degree of accountability play an important role in influencing foreign direct investment flows, since multinational corporations tend to favor destinations with predictable governance and institutional reliability (Teeramungcalanon et al., 2020). Ultimately, the effectiveness of governance depends not only on the presence of institutions but also on how well governments design, coordinate, and enforce policies that create a stable regulatory climate for sustainable private sector participation (Ross, 2019).

Importantly, a high waste management ratio alone does not guarantee environmental success. Even a 100% treatment ratio may still represent millions of tons of residual pollutants, depending on total output. Hence, policymakers should assess qualitative aspects of waste treatment, including disposal methods and toxicity levels, rather than relying solely on numeric indicators.

3.3 Linking FDI inflows and hazardous and toxic (B3) waste management ratio

A comparative analysis between realized FDI and the B3 waste management ratio shows a consistent rise in FDI against a declining environmental performance after 2022. While FDI climbed steadily, waste management peaked in 2022 before deteriorating in 2023-2024. The weakest figure occurred in 2020, when only 60% of hazardous waste was treated, leaving 133,866,892 tons unmanaged. Although the waste data represent combined domestic and foreign activity, the trend indicates that Indonesia is not yet fully prepared to handle increased industrialization sustainably. This disparity highlights the growing challenge of aligning economic expansion with environmental sustainability, emphasizing that the benefits of foreign investment may be partially offset by rising ecological risks.

Interpreting these findings using Miles and Huberman's model, the data reduction and display stages reveal a divergence between economic and environmental trajectories. The conclusion-drawing stage deepens this interpretation by highlighting institutional lag: while FDI inflows expand, environmental governance and infrastructure fail to keep pace. This mismatch suggests that foreign investment can amplify environmental strain when policy frameworks are weak or inconsistently enforced. Moreover, the imbalance points to structural challenges within Indonesia's environmental institutions, including limited waste treatment facilities, uneven regional monitoring, and insufficient coordination between local and central authorities. Without addressing these systemic gaps, industrial growth

could continue to generate environmental pressures that undermine long-term economic and social development.

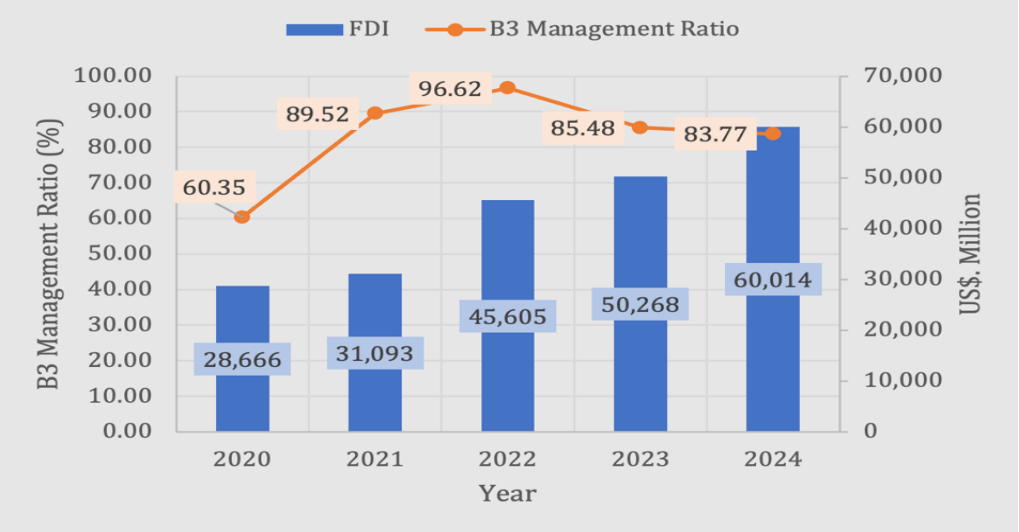

Fig. 3. Trend comparison realization of FDI in Indonesia & hazardous and toxic (B3) waste management ratio 2020–2024.

It is also possible that part of the observed decline results from temporary policy or data fluctuations. For instance, disruptions caused by the COVID-19 pandemic during 2020-2021 may have reduced operational efficiency in waste facilities, delayed monitoring, and constrained investments in cleaner technologies (Vionanda et al., 2024). The rebound of FDI in subsequent years may not have immediately translated into environmental improvements because of lag effects between capital inflow, production activity, and infrastructure readiness. Additionally, differences in sectoral composition contribute to this trend. Manufacturing, the main recipient of FDI, typically produces more hazardous and toxic waste compared to the primary and tertiary sectors, further exacerbating the environmental burden. The uneven distribution of industrial growth across regions also means that some provinces face higher concentrations of waste without proportional access to treatment facilities, creating localized environmental stress.

Overall, the comparative and interpretive analysis shows that Indonesia's environmental management performance has not yet fully adapted to the pace of its growing investment inflows. This reinforces the need for qualitative institutional strengthening, policy alignment, and capacity building. Beyond numerical relationships, the findings underscore the importance of understanding why environmental management lags behind economic progress and how policy reform can close this gap. Future strategies should include targeted infrastructure expansion, stricter enforcement of environmental regulations, and incentives for green-oriented FDI. Coordinated efforts between government agencies, private investors, and local communities are essential to ensure that industrialization does not compromise environmental integrity. By integrating these measures, Indonesia can better balance economic growth with sustainable development goals, ultimately creating a regulatory and industrial ecosystem capable of supporting both investment and environmental protection.

3.4 Policy implications and recommendations

To address these challenges, Indonesia could adopt a series of strategic policy interventions aimed at ensuring that incoming FDI aligns with national sustainability priorities. The government needs to carefully screen and prioritize investments that contribute not only to economic output but also to human capital development, technical training, and institutional capacity-building. These measures are essential to support the

effective and sustainable diffusion of green technologies within industrial sectors. By reinforcing such capacities, developing countries can better align with international environmental targets and sustainability frameworks (Osabuohien-Irabor & Drapkin, 2023). Moreover, firms that demonstrate higher awareness of and exposure to climate-related risks tend to respond more proactively to these challenges, while those with lower awareness often show slower adaptation behaviors (Gu & Hale, 2023). In the context of Indonesia's environmental governance, fostering learning-oriented approaches is essential to improve institutional responsiveness and stakeholder collaboration. Continuous dialogue, cross-sector linkages, and adaptive policy frameworks can enhance the country's capacity to manage environmental challenges more effectively. These strategies align with global findings that highlight the value of experiential learning and shared governance practices in building long-term sustainability (Gerlak et al., 2020). To attract greener FDI, Indonesia should prioritize the development of digitalized environmental governance systems that enable more effective coordination between government, industry, and civil society. Through these systems, private investors can actively contribute by sharing environmental data, technologies, and innovations that support low-carbon growth. Encouraging such multi-stakeholder collaboration not only enhances transparency and regulatory efficiency but also aligns investment practices with sustainability goals, ensuring that foreign capital contributes to long-term environmental resilience. Digitalized governance structures can empower private actors to play a central role in advancing environmental accountability and technological progress (Kloppenburg et al., 2022).

Indonesia should adopt a coherent and adaptive policy framework to attract greener FDI. Instead of increasing regulations, the focus must be on policy consistency, credible incentives, and renewable investment reliability to strengthen environmental governance and long-term sustainability (Jaumotte, 2024). Inward FDI can be effectively utilized by Indonesia to become a greener country, particularly by increasing the use of renewable energy. Transitioning to renewable energy sources often requires substantial investment in infrastructure, technology, and human capital, which can be financially challenging for developing countries like Indonesia. In this context, inward FDI provides not only the necessary capital but also access to advanced green technologies, international expertise, and sustainable management practices. These contributions can help Indonesia overcome the high costs associated with renewable energy development and accelerate its shift toward a low-carbon economy, thereby supporting the country's long-term environmental and economic sustainability (Wani et al., 2024).

Finally, beyond institutional reforms, public transparency and community engagement are essential components of effective environmental governance. Local communities often bear the brunt of industrial waste mismanagement but frequently lack access to critical information or meaningful participation in decision-making processes. Effective governance, therefore, requires adaptive and context-sensitive strategies that evolve in response to both social and ecological conditions, recognizing the complex interdependence between governance systems and their material environments (Van Assche et al., 2020). Enhancing public disclosure of industrial waste data, coupled with robust corporate accountability mechanisms, can simultaneously improve environmental performance and strengthen social trust (Suherlan, 2023). Without such measures, the current pattern, rising FDI alongside declining waste management performance, risks long-term environmental degradation, elevated public health costs, and potential erosion of investor confidence in sustainable markets. Conversely, if policymakers leverage the momentum of economic growth to implement targeted reforms, promote cleaner investments, and strengthen oversight mechanisms, Indonesia could advance toward a sustainable growth model that reconciles industrial competitiveness with ecological responsibility.

In addition, public participation and community-driven monitoring can serve as complementary mechanisms to government enforcement. Civil society organizations, local advocacy groups, and environmental watchdogs can provide valuable oversight, identify gaps in industrial compliance, and encourage firms to adopt sustainable practices voluntarily. Integrating such participatory approaches into national and regional

governance frameworks can help bridge enforcement gaps, particularly in areas where governmental resources and capacity are constrained. Moreover, fostering an informed citizenry can create a culture of environmental accountability, where both private firms and public institutions are incentivized to maintain high standards of ecological stewardship. Over time, such participatory governance arrangements can strengthen environmental institutions, improve regulatory credibility, and contribute to more resilient long-term sustainability outcomes.

Despite these limitations, the study mitigates potential shortcomings by emphasizing contextual interpretation and ensuring that all analyses remain consistent with officially published data. By carefully aligning descriptive insights with empirical trends, the research maintains both validity and reliability, providing a meaningful evaluation of the complex relationship between foreign investment and environmental governance in B3 waste management in Indonesia. Additionally, the study underscores the importance of future data transparency, enhanced reporting mechanisms, and the integration of multi-stakeholder perspectives to fully capture the environmental implications of FDI-driven economic growth.

4. Conclusion

This study has examined the relationship between inward Foreign Direct Investment (FDI) inflows and environmental performance in Indonesia, focusing on the management of hazardous and toxic (B3) waste from 2020 to 2024. The analysis shows that while FDI has consistently increased, particularly in the secondary (manufacturing) sector, the management of industrial waste has not kept pace, revealing a critical gap between economic growth and environmental sustainability. This difference highlights that although FDI contributes significantly to Indonesia's industrial expansion, technology transfer, and employment generation, it also poses potential environmental risks when governance and regulatory enforcement are insufficient, particularly in sectors with high levels of industrial waste generation and limited environmental monitoring capacity across different regions.

The comparative and descriptive findings indicate that rapid industrialization generates substantial hazardous waste that exceeds the current treatment capacity, exposing structural weaknesses in environmental governance. Sectoral differences further illustrate that regions with concentrated industrial growth face heightened ecological pressure due to uneven distribution of waste management infrastructure and monitoring capacity. Economic activities driven by foreign investment must be accompanied by proportional investments in environmental infrastructure and institutional preparedness. Without adequate support systems, the long-term environmental consequences may outweigh the short-term economic benefits generated by industrial expansion. While policy frameworks such as environmental licensing and management regulations exist, their implementation remains inconsistent, limiting the ability to translate economic gains into sustainable industrial practices.

Furthermore, this study emphasizes that FDI's environmental impact is not uniform. Green-oriented investments, which integrate cleaner technologies, sustainable management practices, and corporate accountability, have the potential to improve environmental performance. However, such outcomes depend heavily on the effectiveness of institutional oversight, regulatory consistency, and multi-stakeholder engagement, including civil society, local communities, and private firms. Enhancing transparency, participatory monitoring, and data availability is therefore essential for fostering trust, enabling informed decision-making, and ensuring that industrial growth does not compromise ecological integrity. In addition, stronger coordination between central and regional governments is necessary to ensure that environmental standards are implemented consistently across different provinces and industrial zones. Variations in local enforcement often create disparities in environmental performance, especially in areas experiencing rapid industrial growth. These regional differences suggest that the environmental impact of FDI is closely linked to the consistency of regulatory

implementation and industrial management practices. Moreover, integrating sustainability indicators into investment evaluation processes would help ensure that incoming FDI contributes not only to economic development but also to long-term environmental resilience.

Finally, the research underscores the necessity for strategic policy interventions that align economic and environmental objectives. Indonesia can leverage inward FDI to accelerate renewable energy adoption, technological upgrading, and sustainable industrialization, provided that government institutions strengthen environmental governance, enforce regulations effectively, and promote public participation. Furthermore, instead of adding new regulations, the government should strengthen current regulations by truly implementing them. By combining targeted infrastructure development, adaptive policy frameworks, and multi-sector collaboration, Indonesia can achieve a balanced model of sustainable growth.

Acknowledgement

The author would like to express her gratitude to all parties who have provided support, feedback, and assistance throughout the process of writing this paper

Author Contribution

The study was conceptualized by A.R.Q., who also contributed to the writing, review, and editing of the manuscript.

Funding

This research received no external funding.

Ethical Review Board Statement

Not available.

Informed Consent Statement

Not available.

Data Availability Statement

Not available.

Conflicts of Interest

The author declares no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the author used Grammarly and ChatGPT to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the author reviewed and edited the content as needed and took full responsibility for the content of the publication.

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