

“Why environmental costs go unclassified: Accounting practices and institutional gaps in South Papua, Indonesia”

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WHY ENVIRONMENTAL COSTS GO UNCLASSIFIED: ACCOUNTING PRACTICES AND INSTITUTIONAL GAPS IN SOUTH PAPUA, INDONESIA

Abstract

Large-scale enterprises in developing economies routinely incur environmental expenditures, yet these costs frequently remain unclassified within formal accounting systems, limiting their utility for regulatory evaluation and public accountability. This study examines how environmental cost-recording practices in large-scale enterprises relate to the Environmental Agency's financial control function in South Papua's hazardous waste governance system. A qualitative design was employed, drawing on interviews with eleven informants from two environmental agencies and three large-scale enterprises in the Merauke region, supplemented by secondary hazardous waste data spanning 2017 to 2022. The study finds that both enterprises incur identifiable expenditures across all four environmental management accounting cost categories, covering prevention, detection, internal failure, and external failure, yet none are formally classified as environmental costs in their financial statements. Total hazardous and toxic waste stored reached 88,172.81 cubic meters over the study period, yet the financial footprint of this activity remains invisible within existing accountability structures. The Environmental Agency's supervisory framework is confined to technical document compliance, with no mechanism for engaging enterprise financial cost data. The absence of a regulatory demand signal for environmental cost classification emerges as a recurring and consistent explanation across all informants, operating alongside enterprise-level capacity constraints and the absence of standardized cost classification frameworks. These findings suggest that supervisory framework design warrants greater attention in efforts to close the environmental cost classification gap, and point toward areas warranting further institutional exploration, including the potential role of pollution cost benchmarks and sustainability-linked supervisory performance indicators as directions for future policy development.

Keywords

environmental accounting, waste, classification, accountability, governance

JEL Classification

M41, Q53, H83

INTRODUCTION

A persistent gap exists in environmental accounting research between what enterprises actually spend on environmental management and what becomes formally visible within their accounting systems. In developing economies, large-scale enterprises in resource-intensive industries routinely incur environmental expenditures covering waste transportation, monitoring, audits, and land rehabilitation, yet these costs are frequently absorbed into general operational accounts without classification as environmental costs. This aggregation makes them inaccessible to regulators, auditors, and sustainability reporting mechanisms, leaving the financial dimension of corporate environmental performance effectively invisible within formal accountability structures.

This invisibility constitutes a scientific problem at the intersection of environmental management accounting and public financial control. Classifying environmental costs into distinct categories, namely prevention, detection, internal failure, and external failure, enables more precise managerial and regulatory evaluation of environmental performance (Hansen & Mowen, 2009; United Nations Division for Sustainable Development, 2001), yet this classification rarely materializes in practice even where accounting infrastructure is present (Fadillah et al., 2022; Nofriadi et al., 2025). Conventional explanations point to limited managerial awareness, weak disclosure incentives, or absent classification frameworks. What remains less examined is whether the gap reflects supply-side constraints within the firm or the absence of institutional demand from regulatory agencies whose supervisory frameworks do not engage with environmental cost information at all.

South Papua, Indonesia, presents a context where this question carries particular empirical weight. As a newly established province with active large-scale palm oil, port, and power generation operations, South Papua generates substantial volumes of hazardous and toxic waste, regulated under Government Regulation Number 22 of 2021 concerning the management of substances classified in Indonesian regulation as *Limbah Bahan Berbahaya dan Beracun* (B3). The Environmental Agency, known as *Dinas Lingkungan Hidup*, holds the supervisory mandate over these enterprises, yet the extent to which its oversight framework engages with the financial dimension of enterprise environmental management remains undocumented. Understanding this relationship and the conditions that prevent environmental cost information from functioning as an input into regulatory control is the scientific problem this study addresses.

1. LITERATURE REVIEW

Environmental management accounting (EMA) offers a framework for identifying, measuring, and reporting environmental costs, grouped into prevention, detection, internal failure, and external failure categories (Hansen & Mowen, 2009; United Nations Division for Sustainable Development, 2001). Systematic application supports better managerial decisions on waste reduction, resource efficiency, and regulatory compliance (Huynh & Nguyen, 2024), and extends this value into external accountability once cost analysis is properly structured (Boatca et al., 2023). Even basic environmental cost records can serve regulatory control functions (Taygashinova & Akhmetova, 2019), and combining several costing techniques within one EMA framework makes environmental costs traceable where waste generation is structural to production, a condition mirrored in South Papua's palm oil and port operations (Nyakuwanika et al., 2021), although the field's conceptual foundations remain fragmented compared to more established branches of accounting (Di Vaio et al., 2023). This relevance extends beyond internal management to how regulatory bodies assess corporate environmental performance.

The link between environmental cost disclosure and regulatory oversight has drawn growing attention. Government accounting supervision significantly increases environmental investment by improving disclosure quality and easing financing constraints (Wang et al., 2025), and regulatory agencies retrieve corporate financial reports to inform enforcement investigations in high-pollution industries, positioning environmental cost information as a functional input for public financial control (Li & Wang, 2024). Environmental legislation encourages firms to capitalize environmental expenditures under stronger legitimacy pressure (Wang & Chen, 2022), regulators in less developed assurance markets depend heavily on their own capacity to interpret corporate financial data (Hazaea et al., 2022), and non-governmental organizations prefer government-collected environmental information over corporate voluntary disclosures because of persistent quality deficits in company reports (Wichianrak et al., 2023).

Implementation remains uneven across developing economies despite this recognized importance. Research on developing-country contexts remains thin, leaving settings such as Indonesia's outer regions underexamined (Qian et al., 2021), and Indonesian firms show lower disclosure quality

than Malaysian peers, rarely classify environmental expenditures separately, and lack standardized cost classification frameworks and managerial awareness (Abdullah et al., 2020; Fadillah et al., 2022; Nofriadi et al., 2025). Emerging-economy manufacturers more broadly face incoherent government policy, limited technological readiness, and weak cost-allocation practices (Mukwarami et al., 2023), while Vietnamese enterprises adopt EMA less because of firm size or resources and more because of institutional pressure from regulators and business partners, reinforcing that demand, more than technical capacity, drives classification behavior (Nguyen, 2024). Stringent Vietnamese waste regulations correlate with lower disclosure due to compliance burdens and weak enforcement, while clearer energy frameworks produce the opposite effect (To & Tran, 2025), and top listed Indian companies still report waste accounting narratively instead of in monetary terms, limiting its regulatory usefulness (Adler et al., 2022). Much of this gap traces to weaker institutional isomorphic pressure in developing countries, a pattern also found among small and medium enterprises and best explained jointly through institutional, stakeholder, and resource-based theory (Mukwarami & van der Poll, 2024; van der Poll, 2022). These conditions matter most once environmental costs are folded into general accounts and become invisible to external evaluators. Disclosure structure, more than volume, determines the regulatory utility of environmental cost data; weaker institutional environments produce more superficial non-financial reporting, and two decades of EMA research trace this pattern to the absence of institutional mechanisms that turn environmental cost information into a usable input for external accountability (D'Amore et al., 2025; Grueso-Gala & Camisón-Haba, 2025; Zatini et al., 2025).

Evidence from Indonesia reinforces this pattern directly. Environmental disclosure among listed manufacturing and mining companies has improved but stays concentrated on compliance narratives instead of quantified operational impacts, with governance characteristics, more than regulatory demand, driving disclosure quality (Wahyuningrum et al., 2026), and green accounting adoption among Indonesian manufacturing firms has expanded without a corresponding shift

toward monetized environmental cost disclosure (Adisty & Sumarna, 2025). In the palm oil sector, which shares South Papua's industrial profile, sustainability reporting emphasizes general signaling instead of the granular, classifiable cost data a supervisory agency needs for compliance assessment (Alaika & Firmansyah, 2024; Soleha & Rosiana, 2021), suggesting that the disconnect between environmental cost recording and regulatory financial control is a specific classification gap even where disclosure is otherwise improving.

Legitimacy theory and stakeholder theory together offer a useful lens for understanding why classification fails to emerge even where enterprises possess adequate accounting infrastructure. Organizations converge toward similar structures in response to coercive, mimetic, and normative pressures more than purely technical considerations; legitimacy is tied to an organization's responsiveness to the expectations of audiences it depends on, such as regulators, and stakeholder theory broadens this by holding firms accountable to a wider set of parties, including regulators and affected communities (DiMaggio & Powell, 1983; Freeman, 1984; Suchman, 1995). Legitimacy is the public perception that an organization's actions conform to accepted social norms, and firms under stronger legitimacy pressure tend to produce more extensive and structurally deeper environmental disclosure, a behavior shaped as much by observed institutional expectations as by any single regulator (He et al., 2019; Huang et al., 2022; Luo et al., 2022), though reporting can become decoupled from actual compliance when political interests dominate (Qian et al., 2024). When regulatory agencies treat environmental cost information as a criterion of supervisory evaluation, firms come under pressure to produce it in a classifiable, verifiable form, and without that signal they have little incentive to invest in classification regardless of technical capacity. Even so, legitimacy pressure does not translate uniformly into substantive disclosure quality, since some firms respond strategically instead of genuinely to external scrutiny (Li et al., 2018).

Regulatory agencies clearly shape this dynamic, though their capacity to do so is itself uneven. Structured central inspections encourage substantive environmental improvements, with stronger

effects among firms with better governance, and EMA implementation improves environmental accountability only when supported by adequate governance and institutional capacity (Kopyrina et al., 2023; Rahman et al., 2024). Stronger business-government relations are positively associated with corporate carbon monitoring in developing countries, though this weakens where corruption is present, and regulators across developing countries broadly lack the monitoring and enforcement capacity needed to turn formal rules into substantive outcomes (Blackman et al., 2018; Khan et al., 2026).

A critical tension emerges from this literature. Regulatory agencies can use financial and accounting information effectively to drive genuine environmental improvements (Kopyrina et al., 2023; Li & Wang, 2024; Wang et al., 2025), yet regulatory scrutiny can also produce a chilling effect on voluntary environmental disclosures among firms with weaker governance, yielding fewer quantitative details instead of more substantive reporting (Zakota, 2025), and even where regulatory pressure exists, corporate environmental cost classification stays shallow and inconsistent in the Indonesian context (Abdullah et al., 2020; Fadillah et al., 2022). In sum, environmental cost information can serve as a genuine input for regulatory control; its absence is closely tied to weak institutional and legitimacy pressure in developing economies, and regulatory engagement can cut either way, strengthening substantive disclosure in some settings while triggering defensive reporting in others. What remains unexamined is how this tension plays out where supervisory capacity is itself constrained, and classification standards are absent at both the corporate and regulatory levels.

A further dimension of this problem concerns the statutory basis of environmental financial control. In Indonesia, the supervisory authority of environmental agencies is defined under Law Number 32 of 2009 on Environmental Protection and Management, specifically through Article 71, which mandates oversight of enterprise compliance with environmental protection and management regulations, and Article 74, which enumerates the specific powers of environmental oversight officials, covering inspection, sampling, document review, and site entry. Notably, neither

provision grants environmental agencies the authority to access or evaluate enterprise financial statements or environmental cost records. The absence of environmental cost reporting requirements from the statutory supervisory framework is therefore not a matter of implementation failure or resource constraint alone. It reflects a structural gap in the legal architecture itself, in which environmental financial control falls outside the defined scope of the agency's statutory mandate. This distinction matters for understanding the nature of the problem. Where the gap is one of implementation, supervisory capacity building and resource investment may suffice. Where the gap is one of statutory authority, reform requires legislative or regulatory action to expand the agency's mandate to encompass environmental cost information as a criterion of compliance assessment.

Based on the above discussion, this study aims to examine how environmental cost recording practices in large-scale enterprises relate to the financial control function of the Environmental Agency in South Papua's hazardous waste governance system. This objective is pursued through three specific aims, consisting of assessing how companies record and classify environmental costs within their financial reporting systems, evaluating the degree to which the Environmental Agency's supervisory mechanisms utilize environmental cost information in assessing corporate compliance, and analyzing the implications of the identified gaps for environmental governance and sustainability targets in the region.

2. METHODS

This study adopts a qualitative research design grounded in institutional theory, which holds that governance arrangements and accounting practices are best understood through the lived experiences of actors operating within them rather than through aggregate indicators alone (Saunders et al., 2012). Examining why environmental expenditures remain unclassified in enterprise accounting systems requires access to the interpretive logics, operational realities, and institutional constraints of both regulators and regulated firms, the kind of contextually embedded knowledge that surveys or secondary datasets cannot adequately capture. The frontier character of South Papua, where the

institutional landscape governing environmental oversight and cost reporting remains fluid and under-documented, further justifies an exploratory qualitative approach that can generate theoretically grounded insights for subsequent systematic investigation (Malterud et al., 2016).

Eleven key informants were selected through purposive sampling, targeting individuals with direct operational knowledge of hazardous waste management, environmental supervision, or environmental cost recording within their respective organizations. The sample comprises five officials from two environmental regulatory agencies and six staff members from three large-scale enterprises consistent with the information power framework of Malterud et al. (2016), which holds that a smaller, purposively selected sample with high informational density is preferable to a larger but less focused one. The three enterprises represent distinct operational profiles within South Papua's industrial landscape, covering port logistics at PT PELINDO, palm oil processing at PT Bio Inti Agrindo, and power generation at the State-Owned Gas-Fired Power Plant. Their roles in the analysis differ, however. The State-Owned

Gas-Fired Power Plant informant contributed accounts of oversight mechanisms and supervisory effectiveness, consistent with the first and third thematic dimensions of the interview instrument. The environmental cost classification analysis presented in Table 4 is based on PT PELINDO and PT Bio Inti Agrindo, the two enterprises whose informants provided sufficiently detailed accounts of their environmental expenditure recording practices to support systematic mapping against the EMA cost categories established by Hansen and Mowen (2009). Findings concerning environmental cost classification are therefore explicitly bounded to these two enterprises, and inferences are drawn accordingly. Table 1 presents the profile and organizational affiliation of each informant.

The informant group spans institutional levels and functional roles, from agency secretaries and section heads responsible for regulatory planning to operations managers and environmental staff directly engaged in waste handling and financial recording, enabling the study to capture both regulatory intent and enterprise operational realities. Table 2 summarizes the distribution of informants by gender, age, and educational background.

Table 1. Profile of informants

Informant ID	Position	Organization
Informant 1	Secretary of the Environment Agency	Merauke Regency Environmental Agency
Informant 2	Head of Environmental Coaching and Supervision	Merauke Regency Environmental Agency
Informant 3	Acting Head of Hazardous and Toxic Waste Section	Merauke Regency Environmental Agency
Informant 4	Head of Environment Division	South Papua Provincial Environment and Forestry Service
Informant 5	Head of Hazardous and Toxic Waste Section	South Papua Provincial Environment and Forestry Service
Informant 6	Health, Safety, and Environment Staff	State-Owned Gas-Fired Power Plant, Merauke Regency
Informant 7	Terminal Facilities Staff	PT PELINDO, State-Owned Port Operator, Merauke Regency
Informant 8	Operations Support Manager	PT PELINDO, State-Owned Port Operator, Merauke Regency
Informant 9	Assistant Environment Manager	PT Bio Inti Agrindo, Palm Oil Enterprise
Informant 10	Environmental Air Quality Staff	PT Bio Inti Agrindo, Palm Oil Enterprise
Informant 11	Hazardous Waste Supervisory Staff	PT Bio Inti Agrindo, Palm Oil Enterprise

Table 2. Informant distribution

Characteristic	Category	n	%
Gender	Woman	4	36
	Man	7	64
Age	Above 50 years	1	9
	41 to 50 years	3	27
	30 to 40 years	5	45
	Below 30 years	2	18
Education	Doctoral degree	0	0
	Master's degree	1	9
	Bachelor's degree	9	82
	Diploma	1	9

Note: Percentages are rounded to the nearest whole number and may not sum to 100%.

Primary data were collected through face-to-face in-depth interviews conducted individually with each informant, structured around three thematic dimensions. The first addressed the supervision procedures of environmental agencies, adapted from Malia (2019). The second covered enterprise practices in recording and classifying environmental expenditures within their accounting systems, informed by Alsaïd and Mutiganda (2024) and Imbiri et al. (2023). The third explored the relationship between those accounting practices and SDG accountability, with sustainability-related questions adapted from Alaika and Firmansyah (2024). Secondary data, including environmental management documents, permit records, and hazardous waste volume reports for the period 2017 to 2022, were obtained from the Merauke Regency Environmental Agency to contextualize interview findings empirically. The hazardous waste volume data are presented in Table 3.

Interview recordings were transcribed verbatim and analyzed through qualitative content analysis using NVivo software, which systematically reduces textual data into interpretive categories and improves the accuracy, efficiency, and auditability of the analytical procedure (Hartono et al., 2025; Molinari & de Villiers, 2021; Silva, 2022). The coding approach combined theory-driven and inductive elements. Initial codes drew on Hansen and Mowen's (2009) EMA framework and the principal-agent literature on regulatory information asymmetry (Laffont & Tirole, 1993) as sensitizing concepts, covering categories such as supervisory mandate scope, cost classification practice, and information availability. Open coding was then applied inductively across the full interview corpus, yielding themes including the repeated absence of a pollution cost rate benchmark and the consistent

pattern of recording environmental expenditures without disaggregation. Axial coding established relationships between categories, leading to three interconnected institutional conditions, namely informational asymmetry, resource constraints, and regulatory gap. Each code was operationalized with a descriptive definition and at least two anchor quotations from different informants, and a second researcher independently coded twenty percent of transcripts to check consistency, with disagreements resolved through discussion. The evidentiary chain from interview data to the reported themes is elaborated further at the opening of the Results section

All informants provided informed consent prior to participation, with anonymity protected through the use of numerical identifiers throughout data collection, analysis, and reporting. Personal identifiers were removed before data were stored and will not be disclosed in any form. This study was conducted under Ethical Exemption No. 0942/UN20.1.4/PP/2026 issued by Universitas Cenderawasih, confirming compliance with applicable ethical standards for research involving human participants.

3. RESULTS

Before turning to the findings by thematic area, the analytical pathway from the interview data to the reported themes is worth clarifying. The six oversight mechanisms discussed below were derived inductively from informant descriptions of their supervisory activities, each supported by at least three informant accounts using substantially similar language, and reflect the thematic clustering that emerged from axial coding in NVivo,

Table 3. Hazardous and toxic waste volume in merauke regency, 2017 to 2022

Year	Stored (m ³)			Handled (m ³)			Transferred to Third Parties (m ³)		
	Liquid	Solid	Total	Liquid	Solid	Total	Liquid	Solid	Total
2017	9,159.63	433.98	9,593.61	—	—	—	8,117.43	811.94	8,929.38
2018	4,328.11	253.35	4,581.46	—	—	—	3,991.40	636.27	4,627.67
2019	3,561.50	48.65	3,610.15	—	—	—	2,013.52	534.68	2,548.19
2020	12,497.17	55.59	12,552.76	—	—	—	7,748.03	1,290.25	9,038.28
2021	23,095.63	338.04	23,433.67	—	—	—	21,889.79	666.49	22,556.28
2022	34,267.41	133.75	34,401.16	—	—	—	33,217.90	774.38	33,992.28
5-Year Total	86,909.45	1,263.36	88,172.81	—	—	—	76,978.07	4,714.01	81,692.08

Note: The "Handled" category recorded zero values across all years in the original dataset and is therefore excluded from this table.

where accounts of document review, periodic reporting verification, and field inspection were first coded separately before being organized into a coherent taxonomy of supervisory instruments. The theme of regulatory non-demand for environmental cost classification was not a pre-specified category but emerged consistently across all enterprise informants regardless of whether they were prompted directly on the topic. Informants from PT PELINDO, PT Bio Inti Agrindo, and the State-Owned Gas-Fired Power Plant each volunteered, unprompted, that the Environmental Agency had never requested an environmental accounting report, and this convergence across enterprises is treated as strong evidence of the theme's salience. As a negative case worth noting for transparency, two regulatory informants described their agencies as performing a form of environmental accounting oversight through their monitoring of waste management compliance. These accounts do not contradict the main finding, since neither informant described any mechanism for accessing enterprise financial data, but they indicate that the boundary between technical oversight and financial accountability is perceived differently among agency officials.

Coded interview data identify six mechanisms through which the Environment Agency oversees hazardous and toxic waste management by large-scale enterprises, namely cross-agency coordina-

tion, periodic field visits with direct observation, human resource development through certification programs, physical inspection of temporary waste storage facilities against standard operating procedures, direct mentoring and coaching of enterprise staff, and periodic verification of environmental compliance reports submitted through SIMPEL, the Ministry of Environment and Forestry's Electronic Environmental Reporting System (*Sistem Informasi Pelaporan Elektronik Lingkungan Hidup*), and its successor platform SPEED (*Sistem Pelaporan dan Evaluasi Digital*). The coding structure underlying these findings is presented in Figure 1.

The scale of hazardous waste generation that these mechanisms are designed to govern is substantial. Secondary data in Table 3 show a nearly fourfold increase in stored waste volumes between 2017 and 2022, with third-party processors serving as the sole treatment pathway throughout the study period.

In practice, oversight is weighted heavily toward the administrative end of this spectrum. Enterprises submit environmental management and monitoring matrices every six months through digital platforms, and agency review is confined to document completeness and procedural compliance. All five regulatory informants confirmed that supervisory review does not ex-

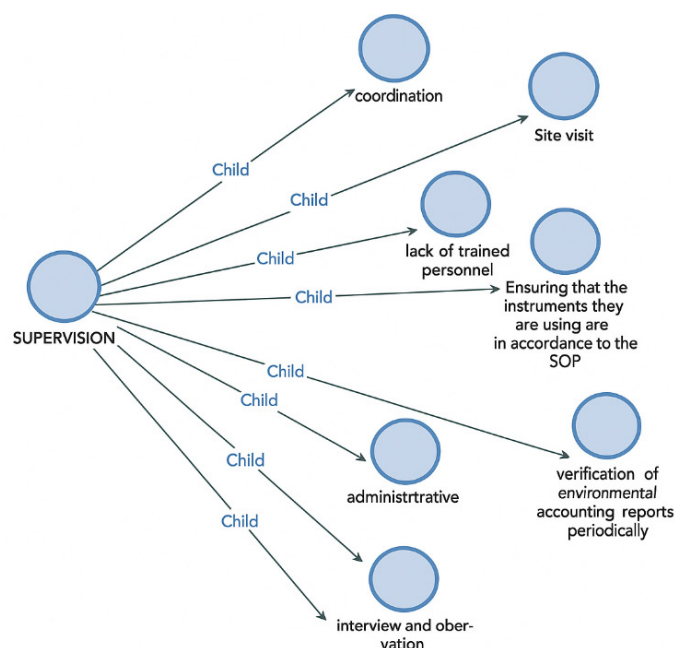


Figure 1. NVivo coding diagram: Environmental Agency oversight mechanisms

tend to enterprise financial statements or environmental cost records, and that no mechanism currently requires enterprises to report environmental costs as a separately classified category, a pattern that held regardless of institutional level and points to a systemic feature of the oversight framework rather than a case-specific limitation. As shown in Figure 2, hazardous and toxic waste oversight is organized around three dimensions, namely the absence of a standard operating procedure specific to hazardous waste oversight, environmental document compliance, and main performance indicators, none of which incorporate financial cost data as an evaluative criterion.

This structure reflects the statutory scope of the agency's mandate under Article 71 and Article 74 of Law Number 32 of 2009 on Environmental Protection and Management, which defines the agency's oversight authority in terms of enterprise compliance with environmental protection regulations and specifies inspection, sampling, and document review as its core tools. Neither provision establishes a basis for accessing or evaluating enterprise financial statements or environmental cost records, so the exclusion of financial cost data from supervisory evaluation is a structural feature of the current legal framework and not merely a gap in implementation.

Taken together, these findings confirm that the Environmental Agency's current oversight mechanisms generate no demand signal for environmen-

tal cost classification at the enterprise level, leaving the financial dimension of hazardous waste governance outside the formal supervisory framework. The environmental cost classification analysis that follows is based on PT PELINDO and PT Bio Inti Agrindo, the two enterprises whose informants provided sufficiently detailed accounts of environmental expenditure recording practices to support systematic EMA category mapping. The State-Owned Gas-Fired Power Plant informant contributed contextual accounts of oversight and supervisory dynamics that inform the broader findings but did not provide the expenditure detail needed for category-level analysis, and the classification findings below should be read as bounded accordingly. This absence of regulatory demand raises the question of how enterprises themselves handle environmental expenditures when no external requirement to classify them exists.

Before presenting the expenditure mapping, it is necessary to state the classification rules applied in this study. Following Hansen and Mowen (2009), prevention costs are expenditures undertaken to prevent the generation of waste or the release of contaminants into the environment, that is, costs incurred proactively before any environmental damage occurs. Detection costs cover expenditures for monitoring, testing, and auditing whether environmental performance meets applicable standards. Internal failure costs arise from activities that produce waste or contaminants not yet released into the external environment. External failure costs are incurred af-

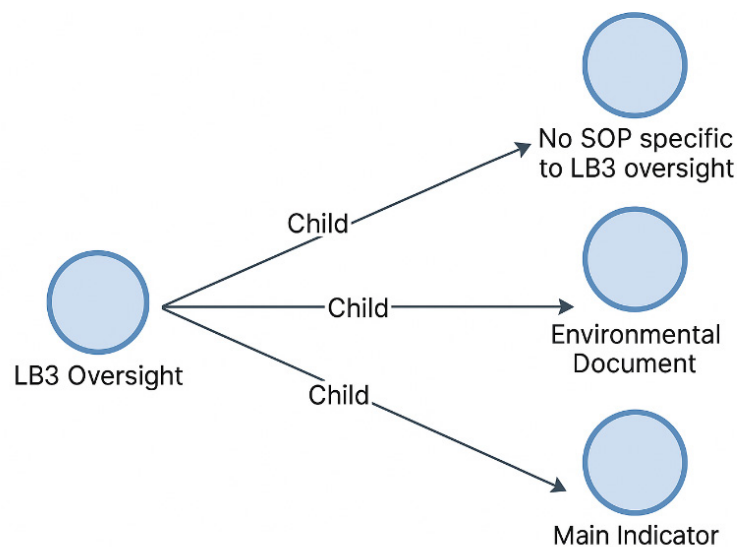


Figure 2. NVivo coding diagram: Hazardous and toxic waste oversight dimensions

ter contaminants or waste have been released and represent expenditures to remediate, compensate for, or manage the consequences of that release.

Applying these definitions to the expenditures identified through interviews produces several mappings that warrant explicit justification. Hazardous waste transportation to licensed third-party processors is classified here as a prevention cost because its purpose is to keep hazardous substances from being released into the local environment by transferring them to an authorized treatment facility before any release occurs, making it a proactive measure rather than a remedial response. Community water quality monitoring at PT Bio Inti Agrindo is classified as an external failure cost because it is conducted in response to the enterprise's recognition that its operations carry a risk to water sources used by surrounding communities, representing an ongoing cost of managing an externality already present in the operational environment. Watershed reforestation and community development pro-

grams at PT Bio Inti Agrindo are likewise classified as external failure costs, because they represent expenditures aimed at restoring or compensating for ecosystem and community impacts resulting from the enterprise's land use and operations, consistent with the Hansen and Mowen (2009) conception of external failure costs as encompassing both remediation and societal damage compensation. Alternative classifications are defensible for some of these items, and the present mapping reflects the closest available alignment between the stated purpose of each expenditure as reported by informants and the conceptual definitions within the selected EMA framework.

Interviews with PT PELINDO and PT Bio Inti Agrindo reveal that both enterprises incur identifiable expenditures across all four environmental cost categories established by Hansen and Mowen (2009). The coding structure capturing these practices, alongside related barriers and SDG contributions, is presented in Figure 3.

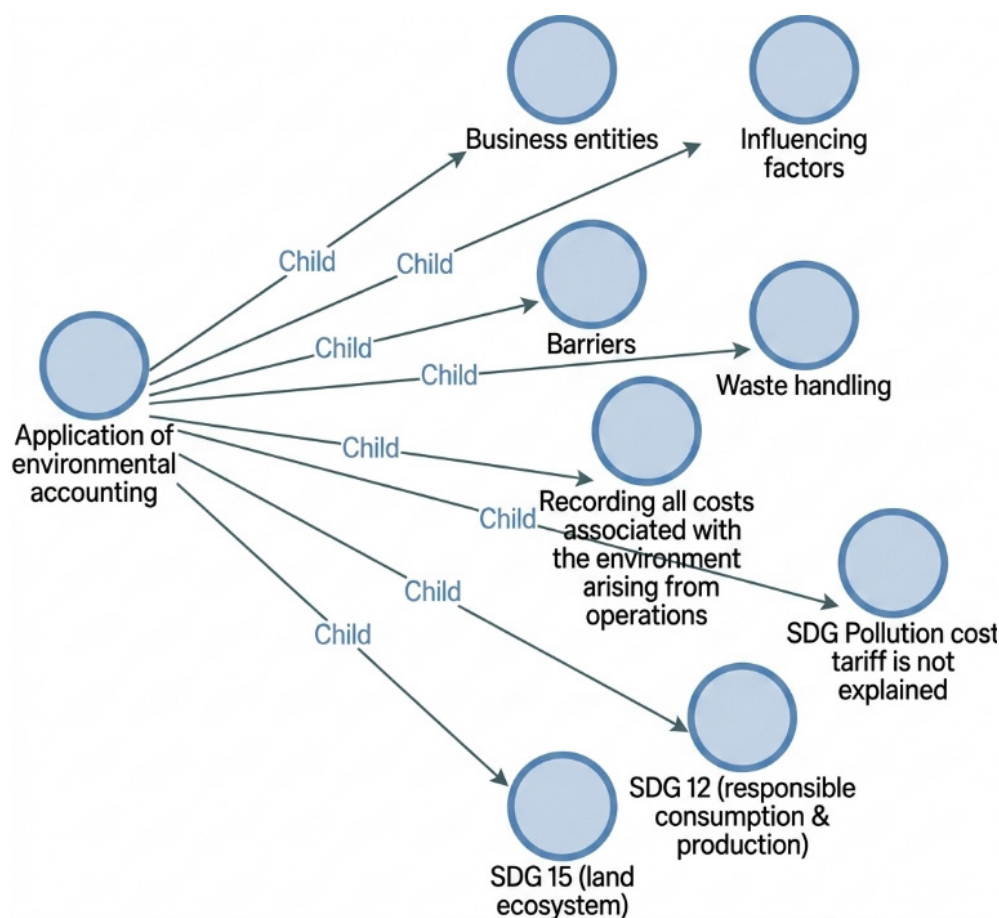


Figure 3. NVivo coding diagram: Environmental cost recording practices and SDG contributions

Prevention costs include annual employee training and hazardous waste transportation to licensed third-party processors outside the region. Detection and assessment costs include semi-annual environmental audits and water and air quality monitoring, alongside participation in PROPER, the Ministry of Environment and Forestry's Corporate Performance Rating Program (*Program Penilaian Peringkat Kinerja Perusahaan*). Internal failure costs are limited, comprising minor spill cleanup at PT PELINDO and an emergency response system at PT Bio Inti Agrindo aligned with Ministry of Environment and Forestry Regulation No. 74 of 2019. External failure costs include mangrove rehabilitation, community water quality monitoring, watershed reforestation, and community development programs. The full distribution of identified expenditures across EMA cost categories is presented in Table 4.

Despite the scale of these expenditures, none are formally classified as environmental costs in either enterprise's financial statements. All are recorded within integrated financial accounting systems as general operational expenditures, indistinguishable from routine business costs for purposes of regulatory review or public reporting. Enterprise informants confirmed that these environmental costs are included in financial statements but have never been separated into a distinct category, with expenditures such as waste transportation, staff training, audits, and reforestation all recorded within the general accounting system, and noted that the Environmental Agency has never requested a specific environmental accounting report, leaving agency oversight concentrated on technical and administrative compliance instead of financial classification.

It is important to note that the presence of integrated financial accounting systems within these enterprises does not, by itself, confirm that they possess the specific environmental-accounting capability needed to generate reliable EMA classifications by waste type, volume, environmental risk, or cost driver. What the interviews establish is that both enterprises record environmental expenditures as aggregate cost line items within their general operational accounts, and that accounting personnel are familiar with the categories of expenditure incurred. Neither enterprise, however, demonstrated a systematic internal practice of disaggregating these expenditures according to EMA cost categories, linking cost entries to specific waste volumes or risk profiles, or producing any internal environmental cost report approximating the structure required for formal EMA classification. The accounting infrastructure is present in the sense that transactions are captured and traceable, but the environmental-accounting capability, understood as the organizational routines, classification logic, and reporting templates needed to translate those transactions into verifiable EMA categories, has not been developed within either enterprise.

This account is consistent with the position conveyed by PT PELINDO informants and aligns with the broader supervisory picture provided by the State-Owned Gas-Fired Power Plant informant, who similarly confirmed that environmental expenditures are captured within the enterprise's integrated financial accounting system without specific environmental cost labeling, and that no request for separately classified environmental cost reporting has ever been received from the Environmental Agency. Across all three enterprises, environmental expenditures are embedded

Table 4. Environmental expenditures by EMA cost category, PT PELINDO and PT Bio Inti Agrindo

EMA Cost Category	PT PELINDO	PT Bio Inti Agrindo
Prevention costs	Employee training (IDR 5-10 million/year); hazardous waste transportation (IDR ~ 100 million/year)	Employee training (IDR ~ 10 million/participant); hazardous waste transportation (IDR ~ 40 million/shipment)
Detection and assessment costs	Environmental audits and water/air quality monitoring (IDR 20-70 million/year)	Semi-annual environmental audits and quality monitoring (IDR 250-300 million/cycle); PROPER participation
Internal failure costs	Minor spill cleanup expenditures	Emergency response system (aligned with MoEF Regulation No. 74/2019)
External failure costs	Mangrove rehabilitation (IDR ~ 30 million/year)	Community water quality monitoring (IDR ~ 150 million/year); watershed reforestation; community development

within general operational cost categories in ways that make them invisible as environmental costs to any external evaluator, whether a regulator, an auditor, or a sustainability reporting body. These findings indicate that the classification gap observed across both enterprises is closely associated with the absence of any regulatory or institutional mechanism that requires or rewards formal environmental cost disaggregation within enterprise financial reporting systems. Whether this absence constitutes the primary cause of the gap, relative to managerial capacity constraints or the absence of standardized classification frameworks, cannot be established with certainty from the present qualitative design, though it emerges as a consistent and recurring explanation across all enterprise and regulatory informants.

This classification gap carries consequences that extend into the broader accountability system through which sustainability progress is tracked. Community water quality monitoring at PT Bio Inti Agrindo represents a tangible contribution to SDG 6, particularly target 6.3 on reducing water pollution, and to SDG 3, specifically target 3.9 on reducing illness from hazardous chemical exposure. Mangrove rehabilitation at PT PELINDO and watershed reforestation at PT Bio Inti Agrindo constitute measurable contributions to SDG 14 on life below water and SDG 15 on life on land. The near-complete transfer of hazardous and toxic waste to licensed third-party processors across both enterprises is relevant to SDG 12, particularly target 12.4 on the environmentally sound management of hazardous wastes, and to SDG 13 on climate action.

A further dimension of the accountability gap concerns the absence of a standardized pollution cost rate at the provincial level. Without a regulatory benchmark specifying the financial liability per unit of hazardous waste generated, enterprises have no reference point for disaggregating expenditures by waste type, volume, or risk, and even if classification were attempted, the resulting figures would lack a common metric for regulators to assess their adequacy. The polluter pays principle, as described in the EMA literature, presupposes precisely such a measurement framework as a precondition for meaningful environmental cost accountability (United Nations Division for

Sustainable Development, 2001), and its absence in South Papua marks an area where future regulatory development would be needed before environmental cost classification could serve its intended accountability function. Consequently, the financial data needed to assess enterprise contributions to SDG 12, target 12.4, cannot be constructed from existing records, since these do not carry unit-level cost information, and regulatory informants acknowledged this gap directly, noting that properly recorded environmental costs would help the agency assess the transparency of enterprise environmental commitments, but that oversight attention remains concentrated on technical reports and environmental management matrices instead. Because none of these expenditures are classified as environmental costs or linked to any regulatory performance indicator, they cannot be aggregated or formally reported as contributions to provincial SDG progress, reflecting the broader structural disconnect between environmental cost information held within enterprise financial systems and the mechanisms through which SDG progress is assessed provincially.

4. DISCUSSION

The findings of this study reveal a structural disconnect between environmental cost recording practices at the enterprise level and the financial control function of the Environmental Agency in South Papua's hazardous waste governance system. This disconnect operates through three mutually reinforcing conditions, namely the absence of environmental cost classification within enterprise accounting systems, the exclusion of financial cost data from agency supervisory mechanisms, and the consequent invisibility of enterprise environmental contributions within provincial SDG accountability frameworks. Each of these conditions merits interpretation against the existing literature.

The finding that both PT PELINDO and PT Bio Inti Agrindo incur substantial expenditures across all four EMA cost categories while failing to classify any of them as environmental costs is consistent with the pattern documented by Fadillah et al. (2022), who found that separately classifying environmentally related expenditures remains uncom-

mon among Indonesian firms even where such expenditures are routinely incurred, and with Nofriadi et al. (2025), who identify the absence of standardized cost classification frameworks and limited managerial awareness as persistent barriers to EMA implementation in the Indonesian context. What the present study adds to this picture is a more precise account of where classification fails to emerge. Both enterprises record environmental expenditures within integrated financial accounting systems, and their personnel are familiar with the expenditure categories incurred, a form of general accounting infrastructure that nonetheless falls short of what the EMA literature would recognize as environmental-accounting capability, that is, the organizational routines and reporting logic needed to map expenditures to specific EMA categories by waste type, volume, risk, or cost driver. Neither enterprise has developed that capability, and no internal initiative to do so appears to have been undertaken in the absence of an external requirement. This is consistent with Zhao et al. (2025), who find that disclosure structure is ultimately shaped by the regulatory utility external actors assign to it. The present study cannot rule out that managerial capacity constraints or limited awareness of EMA frameworks also contribute to the gap, but the evidence consistently points to the absence of external demand as a recurring, structurally embedded condition that existing capacity alone would not be sufficient to overcome.

The supervisory findings extend and complicate the conclusions of B. Li and Wang (2024), who demonstrate that environmental regulatory agencies in developed economy settings retrieve corporate financial reports to inform enforcement investigations, particularly for high-pollution industries. In South Papua, no equivalent practice exists. The Environmental Agency's oversight framework is organized exclusively around technical compliance indicators, document verification, and administrative reporting through digital platforms, with no mechanism for retrieving or evaluating enterprise financial cost data. This finding echoes T. Wang and Chen (2022), who show that legislative environmental mandates alone are insufficient to drive substantive environmental cost capitalization unless accompanied by active external supervision that engages with financial reporting. The South Papua case illustrates what happens when

that supervisory engagement is absent at the institutional design level and not only at the implementation level, confirming the theoretical prediction of Laffont and Tirole (1993) that constrained regulators will systematically rely on observable administrative proxies instead of outcomes-based financial data. As established earlier, this constraint traces to the statutory scope of the agency's mandate under Law Number 32 of 2009, so even a well-resourced agency operating within the current legal framework would lack the formal basis to treat environmental cost information as a regulatory input. The problem is therefore one of statutory design as much as institutional capacity, a distinction that carries real implications for the type of reform needed.

The resource constraint and informational asymmetry findings reported in this study are consistent with Kopyrina et al. (2023), who observe that intensive regulatory oversight capable of driving genuine corporate environmental improvements requires a level of supervisory resource mobilization that most developing economy agencies cannot sustain on a routine basis. Rahman et al. (2024) similarly find that EMA implementation improves environmental accountability only when supported by adequate governance structures and institutional capacity, and that either element alone is insufficient. Blackman et al. (2018), reviewing environmental regulation across developing countries more broadly, reach a parallel conclusion, showing that regulators in these settings frequently lack the monitoring and enforcement capacity needed to translate formal rules into substantive outcomes. The South Papua case fits that broader pattern, though whether it reflects a structural feature of developing economy supervision in general or conditions specific to a newly established frontier province is a question comparative research across contexts would need to address. Governance structures and institutional capacity appear underdeveloped in complementary ways here, with the agency lacking the personnel, equipment, and budget for independent field verification, while enterprises lack any external accountability pressure to classify their environmental costs formally, producing a self-reinforcing equilibrium in which neither party demands the information that would make the other's accountability function more effective.

The regulatory gap finding, specifically the absence of a standardized pollution cost rate at the provincial level, connects to a broader observation in the EMA literature about the role of reference benchmarks in shaping classification behavior. Taygashinova and Akhmetova (2019) argue that basic environmental cost records can serve regulatory control functions without disrupting existing accounting systems, but only when a common measurement framework exists to translate physical waste volumes into financially quantifiable liabilities, a condition absent in South Papua, leaving enterprises without a basis for determining what a formally classified environmental cost should look like and regulators without a basis for judging whether recorded expenditures are adequate. Boatca et al. (2023) make a related point in showing that structured environmental cost analysis supports external accountability precisely because it creates a shared language between the firm and its regulatory environment. Where that shared language is absent, as in South Papua, the accountability function cannot operate regardless of the goodwill of either party.

The finding that enterprise environmental expenditures carry direct relevance to multiple SDG targets yet remain invisible within provincial accountability frameworks connects to a tension in the literature between regulatory oversight as a driver of substantive disclosure and as a trigger for defensive or superficial reporting. Zakota (2025) finds that regulatory scrutiny can produce a chilling effect on voluntary

environmental disclosures among firms with weaker governance, yielding fewer quantitative details instead of more substantive reporting. In South Papua, however, the problem is not that oversight pressure produces defensive responses, but that oversight pressure simply never reaches the financial dimension of environmental performance at all. A. Wang et al. (2025) show that government accounting supervision can significantly increase environmental investment by improving disclosure quality and easing financing constraints, though this effect depends on supervisors actually engaging with financial accounting data. Realizing that potential in settings like South Papua would require prior development of the supervisory frameworks, cost classification standards, and pollution cost benchmarks that would make such engagement feasible, though designing and implementing these instruments falls beyond what the present qualitative study can directly prescribe. Abdullah et al. (2020) attribute Indonesia's comparatively lower environmental disclosure quality to a less developed voluntary disclosure environment. The South Papua evidence adds a further institutional dimension to this picture, suggesting that regulatory demand for environmental cost information has not yet been institutionalized in a form enterprises can respond to, even where accounting infrastructure is present. This observation is specific to the South Papua context and should be read as generating a hypothesis worth testing in other settings, not as evidence of a general mechanism across developing economies.

CONCLUSION

This study examined how environmental cost recording practices in large-scale enterprises relate to the financial control function of the Environmental Agency in South Papua's hazardous waste governance system. The findings show that PT PELINDO and PT Bio Inti Agrindo incur substantial expenditures across all four environmental management accounting cost categories, yet neither enterprise has developed the environmental-accounting capability needed to disaggregate those expenditures into formal EMA categories by waste type, volume, risk, or cost driver, even though both record them within integrated financial accounting systems. This distinction matters because a general accounting system does not automatically translate into the capacity for environmental cost classification, and developing that capability does not appear to have been pursued in the absence of an external requirement to do so. Across all informants, the absence of a regulatory demand signal for environmental cost classification emerges as a consistent structural condition shaping this outcome, alongside other contributing factors such as the absence of standardized EMA classification frameworks and limited managerial familiarity with formal environmental cost categories, while the Environmental Agency's oversight framework remains organized exclusively around technical compliance and document verification, leaving it without any mechanism for engaging with enterprise financial cost data.

This institutional configuration leaves enterprises with no incentive to classify environmental costs and the agency without the financial evidence needed to move beyond administrative oversight. The novelty of this study lies in reframing the environmental accounting implementation problem from a question of corporate disclosure capacity to one of regulatory demand architecture, without dismissing the role of managerial awareness and classification capacity as contributing factors. This finding is specific to the South Papua context and cannot be read as evidence of a general mechanism applicable to developing economies as a whole. Its analytical value lies in generating questions for future investigation, particularly whether the statutory exclusion of environmental cost data from supervisory mandates and the absence of pollution cost benchmarks are features shared by comparable frontier industrial provinces in Indonesia and elsewhere, questions that would require comparative research designs beyond the qualitative, single-province inquiry conducted here.

This study is not without limitations. Access constraints meant that not all targeted enterprises participated, and the absence of detailed financial statement data limited the depth of analysis on environmental cost measurement practices. Future research could extend this inquiry through comparative studies across Indonesian provinces with differing levels of institutional development to assess whether the statutory and capacity constraints identified here are region-specific or reflect a more systemic pattern, and quantitative investigation of the relationship between supervisory framework design and environmental cost classification quality at a broader scale would further strengthen the analytical transferability of these findings.

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