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Between Regulation and Reality: Assessing Local Policy Implementation for B3 Waste Management in Dumai's Palm Oil Sector

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ABSTRACT

Indonesia's rapid palm oil industry growth has positioned the country as a global production leader while generating large volumes of hazardous and toxic (B3) waste that threaten environmental sustainability and public health. To address this, Dumai City enacted Regulation No. 5 of 2017 on Environmental Protection and Management. However, persistent improper disposal practices highlight a critical gap between policy formulation and on-the-ground implementation. This study examined the implementation of this regulation by palm oil companies in Dumai, focusing on policy content and contextual dynamics. Using a qualitative design, data were collected through in-depth interviews with 29 stakeholders from government agencies, palm oil corporations, environmental NGOs, local media, academics, and affected residents, complemented by field observations and document analysis. Data were analyzed with NVivo 12 Plus using group query, crosstab query, and matrix coding query to map multi-actor perspectives on regulatory effectiveness. Findings reveal weak implementation caused by centralized decision-making, inadequate resources, institutional rigidity, low public participation, and limited enforcement capacity. From a policy content perspective, decision-making is dominated by the central government, leaving local authorities minimal discretion and resulting in fragmented supervision. From a policy context perspective, institutional arrogance, conflicting interests, and low compliance further hinder effective implementation. This study offers a novel contribution by integrating environmental governance theory with consumer protection law to evaluate local environmental regulation. It shows that effective B3 waste governance requires not only legal instruments but also inclusive collaboration, institutional trust, and strong local commitment.

1. INTRODUCTION

The escalating expansion of the palm oil industry has positioned Indonesia as the world's leading producer, yet this remarkable economic achievement comes at an environmental cost. As global demand for palm oil increases, its production generates palm oil mill effluent (POME) and related waste streams that threaten ecosystems and public health through soil and water contamination [1, 2]. Soils exposed to POME show altered chemical properties, including shifts in exchangeable bases such as Na, Mg, K, and Ca, highlighting the need for effective waste management [3]. When properly managed, POME can improve soil quality and crop productivity, as shown in case studies from Indonesia [4]. However, in Indonesia and Malaysia, unregulated POME discharge challenges environmental governance in industrial areas, underscoring the urgency of wastewater treatment, monitoring, and sustainable reuse frameworks [2, 4]. Its health-related impacts are also evident, with POME exposure affecting haematological parameters in Nile tilapia, raising broader public health concerns [5].

Historically, Indonesia has dominated the global palm oil market, producing an estimated 44 million metric tons (MT) or 57% of global output, surpassing Malaysia and Thailand. This dominance is illustrated in Figure 1, which highlights Indonesia's contribution of 46.5 million MT in 2024, representing 59% of the global total (USDA, 2024). While this economic contribution boosts national revenue and creates employment, it simultaneously intensifies the production of hazardous waste, magnifying the complexity of environmental management. Within the framework of the Sustainable Development Goals (SDGs), particularly Goal 6 (Clean Water and Sanitation) and Goal 12 (Responsible Consumption and Production), effective B3 waste management is not merely a local responsibility but a global commitment [6].

Despite Indonesia's regulatory strides, the implementation of national environmental regulations, such as Law No. 32 of 2009, has faced significant challenges, especially under decentralized governance. Issues such as institutional capacity constraints, inconsistent intergovernmental coordination, and

uneven enforcement undermine the intended impact of these policies [6]. The economic weight of the palm oil sector in Sumatra further complicates the matter.

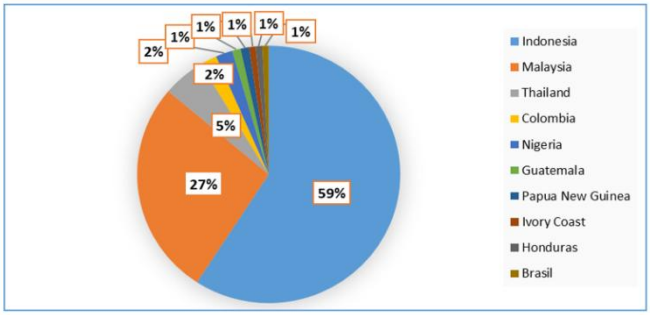

Figure 1. Countries with the largest palm oil production in the world

As shown in Table 1, Riau Province records the highest investment value at Rp25.29 trillion across 4,340 projects, far surpassing other provinces. This underscores the strategic role of Riau as the economic backbone of Indonesia's palm oil industry. However, this economic concentration has escalated environmental pressures, creating a conflict between economic growth and sustainable environmental stewardship.

Within Riau, Dumai City functions as a critical palm oil export hub and industrial node, which magnifies its role in the environmental governance landscape. According to Table 2, Dumai contributes significantly to domestic investment (Rp2.65 trillion) through 362 projects, employing both local and foreign workers. Yet, the city has also experienced a marked rise in B3 waste volumes over the past decade, exacerbated by substandard waste management practices such as untreated wastewater discharges and unsafe boiler ash storage. The concentration of palm oil investment in Dumai creates a unique and challenging policy implementation context. As a key export hub, the city's economy is heavily dependent on the sector, creating a powerful industrial lobby and institutional reluctance to enforce regulations perceived as potentially disruptive to economic activity. This economic structure leads to conflicting priorities for local agencies, which are tasked with both fostering investment and ensuring environmental protection. Furthermore, the high volume of waste generated by concentrated processing facilities outstrips the technical and financial capacity designed for a more diversified urban setting. These factors, economic dependency, conflicting institutional mandates, and capacity mismatch, create distinct barriers to implementing environmental regulations that are less pronounced in regions with more diversified economies or lower industrial density**.** Past studies have often focused on the environmental impact of palm oil activities or on regulatory formulation at the national level [7, 8], but there remains a limited understanding of how local governments implement specific regulations to manage B3 waste in such high-pressure industrial contexts.

Table 1. Foreign and domestic investment in provinces across Sumatra in 2024

Foreign and Domestic Investment in Rupiah		
Province	**Investment (Rp)**	**Project**
Riau	25.290.200.000.000	4.340
Sumatera Selatan	14.143.100.000.000	5.006
Kepulauan Riau	10.283.800.000.000	4.993
Sumatera Utara	10.133.800.000.000	7.271
Kep. Bangka Belitung	3.248.200.000.000	1.482
Lampung	2.733.000.000.000	3.017
Jambi	2.441.100.000.000	2.187
Aceh	2.348.400.000.000	3.379
Sumatera Barat	1.838.100.000.000	1.844
Bengkulu	1.208.100.000.000	1.059

Source: DPMPTSP of Riau Province (2024)

Table 2. Investment and labour absorption by regency/city in Riau Province in 2024

Regency/City	Project	Domestic Investment		
		Investment (Rp)	Indonesian Workers	Foreign Workers
Pelalawan	248	6.851.957.818.885	18.891	–
Siak	189	4.129.454.287.951	717	–
Bengkalis	378	3.800.632.546.056	722	1
Kota Dumai	362	2.651.202.307.249	395	1
Kota Pekanbaru	2.075	1.680.430.604.261	2.491	–
Rokan Hulu	133	1.437.070.880.933	1.649	1
Indragiri Hilir	144	1.374.590.108.886	3.847	1
Kampar	360	1.306.989.969.125	1.367	–
Indragiri Hulu	218	933.385.104.509	825	1
Kuantan Singingi	81	805.266.441.831	937	–
Rokan Hilir	114	306.658.411.471	6.379	–
Kep. Meranti	38	12.724.001.143	4	–

Source: DPMPTSP of Riau Province (2024)

This lack of localized empirical evaluation creates a critical research gap. While studies like [9, 10] have explored hazardous waste management system design and policy frameworks, they rarely investigate the local-level execution of such frameworks in decentralized settings. Similarly, previous research often examines either policy design or environmental consequences in isolation [11, 12], neglecting the interplay between multi-actor governance dynamics and actual regulatory outcomes on the ground. Without this integrative perspective, it is difficult to identify why local environmental regulations often fail to achieve their objectives, especially in complex industrial landscapes like Dumai.

Against this backdrop, this study introduces a novel contribution by integrating the theoretical lens of environmental governance with the legal perspective of consumer protection to evaluate the implementation of Dumai City Regulation No. 5 of 2017. This dual-lens approach is rarely applied in existing literature, making the study distinctive in highlighting how local regulatory performance directly affects community rights to a healthy environment as part of consumer protection mandates.

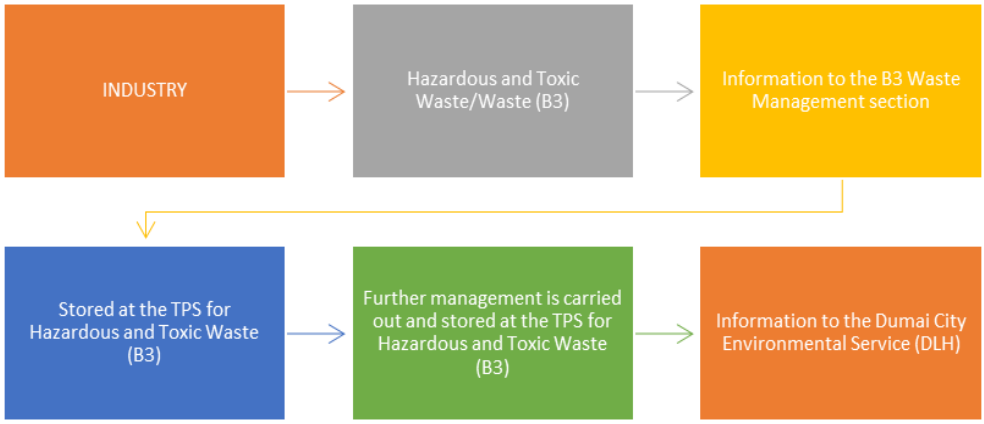

Figure 2. Hazardous and toxic waste processing flowsheet (B3)

As it operates in the lived complexity of a palm oil hub. By reading implementation against the normative process in Figure 2, the study connects technical compliance duties to the legal right of communities to a healthy environment, moving beyond generic design critiques toward grounded assessments of whether regulatory chains actually protect people and places [13].

Moreover, this study addresses a previously unexplored dimension: the interconnection between policy content (program design) and policy context (implementation dynamics) in determining the effectiveness of hazardous waste regulation at the subnational level. The significance of this study lies in its potential to provide actionable insights for policymakers, regulatory agencies, and industry stakeholders. Specifically, it aims to analyze the process, influencing factors, and outcomes of implementing Dumai City Regulation No. 5 of 2017 on B3 waste management by palm oil companies. By employing a qualitative approach with data gathered from multiple stakeholders, including the Environmental Agency, industry actors, NGOs, media, academics, and affected residents, this study seeks to reveal the multi-actor dynamics that shape regulatory outcomes. Understanding these dynamics is crucial for designing more adaptive and context-sensitive environmental governance frameworks in Indonesia's decentralized system.

Overall, this study contributes to bridging the persistent gap between environmental policy design and field-level implementation in decentralized governance contexts. It offers empirical evidence that can inform not only the improvement of B3 waste governance in Dumai but also the broader development of subnational environmental regulatory systems in other palm oil-producing regions. By highlighting the importance of multi-actor engagement and legal empowerment, the study underscores that effective hazardous waste management requires more than regulations; it requires an ecosystem of shared accountability, local ownership, and sustained institutional commitment.

2. METHOD

This study employed a qualitative research approach to investigate how Dumai City Regulation No. 5 of 2017 is implemented in the management of hazardous and toxic (B3) waste by palm oil companies. A qualitative design was considered appropriate to explore multi-actor governance dynamics within their real-world context, allowing an in-depth understanding of complex socio-environmental interactions and policy processes [14].

Table 3. Summary of data collection

Data Source	Type of Data	Informant Group/Document Type	Number (n)	Description/Role
Primary data	In-depth Interviews	Dumai Environmental Agency (DLH) officers	5	Government actors responsible for the supervision and enforcement of environmental policies
		Palm oil companies/B3 waste handlers	6	Industry actors managing production processes and waste handling
		Local Environmental NGOs	4	Civil society actors monitoring environmental compliance and advocacy
		Local media	3	Journalists covering local environmental issues and industry practices
		Academics	3	Scholars specializing in environmental policy and governance
		Affected residents	8	Community members directly impacted by B3 waste pollution
	Field Observations	Palm oil processing facilities	5	On-site visits to document infrastructure, operational practices, and compliance
		Residential areas near industrial zones	2	Community-level observations of environmental and health impacts
	Document Analysis	Local regulations, official report, policy brief	16	Legal, Policy, and technical documents on B3 waste management in Dumai
Secondary data	Literature Review	Government websites, journals, books and proceedings	–	Contextual data, theoretical frameworks, and supporting evidence

2.1 Data sources

The data collection strategy in this study was designed to capture multi-actor perspectives on the implementation of Dumai City Regulation No. 5 of 2017. A total of 29 informants were purposefully selected from six stakeholder groups, namely government, industry, civil society, media, academia, and affected communities, to ensure representation of diverse institutional roles and lived experiences. This diversity enabled the study to examine both formal regulatory practices and community-level responses to B3 waste governance.

As shown in Table 3, data collection also included field observations in five palm oil processing facilities and two nearby residential areas to gain first-hand insights into operational practices, site conditions, and visible environmental impacts. In addition, 16 local policy documents and regulatory reports were analyzed to map the legal and institutional framework of B3 waste management, while secondary data from government statistics, scholarly publications, and conference proceedings offered broader contextual insights. This triangulated approach, which combined interviews, observations, and document analysis, enhanced the credibility and depth of the dataset and supported a thorough analysis of the regulation's content and the contextual dynamics shaping its implementation.

2.2 Data collection procedures

Data collection was conducted over three months using three complementary qualitative techniques:

1) Document analysis was carried out on 16 local and national regulatory documents, policy briefs, and official reports related to B3 waste management and palm oil industry activities in Dumai.

2) Field observations were undertaken at five major palm oil processing facilities and two community sites affected by B3 waste to record physical conditions, compliance practices, and community responses.

3) Semi-structured interviews formed the core of primary data collection. Interviews were guided by a question framework addressing policy implementation processes, institutional roles, resource allocation, public participation, and compliance behavior. Each interview lasted between 45 and 90 minutes, was conducted face-to-face or via video call, and was audio-recorded with informed consent.

Interview transcripts were prepared verbatim, and observational notes were compiled to provide contextual depth. This multi-method approach ensured data saturation and strengthened the credibility of findings by allowing cross-verification of evidence across sources.

2.3 Data analysis

The data were analyzed systematically using NVivo 12 Plus software to manage, code, and interpret qualitative data. The analysis followed several stages:

1) Open and axial coding to identify recurring themes, categories, and subcategories from transcripts, documents, and field notes.

2) Group query and crosstab query to explore frequency patterns and compare themes across stakeholder groups.

3) Matrix coding query and project map analysis to visualize relationships between variables affecting regulatory implementation, including decision-making authority, resource allocation, and public participation.

This approach facilitated rigorous theme development, ensured transparency in coding, and helped trace linkages between policy content and contextual implementation factors [15, 16].

2.4 Trustworthiness and ethical considerations

Credibility was enhanced through triangulation of data sources, prolonged engagement in the field, and member checking to validate interpretations with several informants. Ethical research principles were strictly observed by securing informed consent, protecting anonymity, and ensuring voluntary participation. These measures reinforced the trustworthiness, dependability, and confirmability of the study's findings on the implementation of Dumai City Regulation No. 5 of 2017.

3. RESULTS AND DISCUSSION

3.1 Implementation of Dumai City Regulation No. 5 of 2017 from the policy content (program design) perspective

Essentially, the hazardous and toxic (B3) waste control program aims to ensure proper B3 waste management to prevent environmental pollution and protect public health. It also seeks to raise community awareness about the dangers of B3 waste while ensuring compliance with applicable regulations. Currently, this program does not yet have a dedicated local regulation and still operates under Dumai City Regulation No. 5 of 2017 on Environmental Protection and Management. The Dumai Environmental Agency (DLH) is responsible for supervising and enforcing environmental regulations and should ideally safeguard environmental sustainability and improve the community's quality of life.

The analysis of the implementation of Dumai City Regulation No. 5 of 2017 highlights six critical indicators of policy content: affected interests, types of benefits, expected levels of change, decision-making location, program implementers, and allocated resources. These indicators are illustrated in the group query analysis below.

Figure 3 presents a visual map of stakeholder perspectives using interconnected lines and nodes to illustrate the relationships among them. Each indicator is accompanied by directional arrows that signify specific recommendations proposed by different stakeholders, allowing a clearer understanding of how these perspectives interact and influence one another. As highlighted by Grindle and Thomas [17], the effectiveness of policy implementation is largely determined by the quality of its design, since the structural design of a policy program shapes the implementation process and significantly affects its outcomes for both organizations and individuals.

Further analysis using the crosstab query, as illustrated in Figure 4, reveals that the informants presented a wide range of perspectives regarding the policy content dimension of the B3 waste control program implemented in Sungai Sembilan District, Dumai City. This variation in viewpoints highlights differing perceptions and expectations about how the program is designed and how effectively it addresses local waste management challenges.

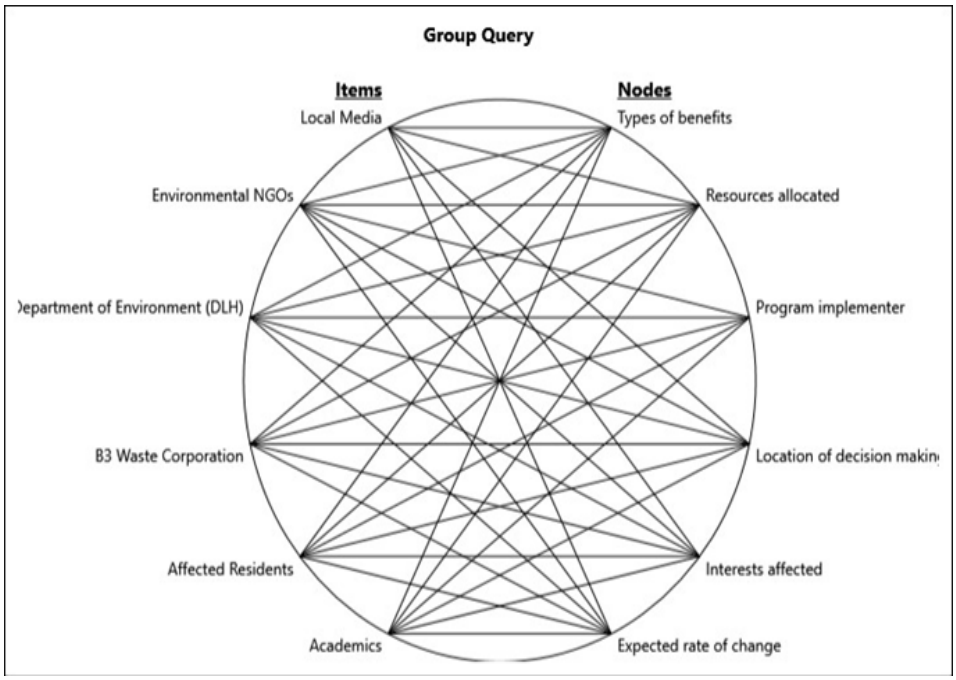

Figure 3. Implementation of Dumai City Regulation No. 5 of 2017 from the policy content (program design) perspective

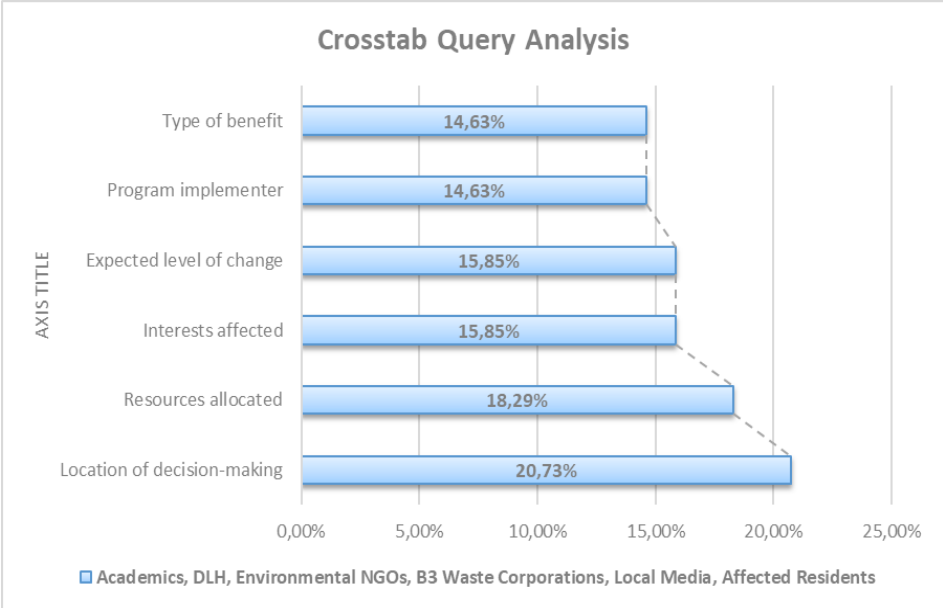

Figure 4. Crosstab query analysis of stakeholder perspectives on policy content in the implementation of Dumai City Regulation No. 5 of 2017

As shown in Figure 4, decision-making location emerged as the dominant factor (20.73%), followed by allocated resources (18.29%), expected level of change and affected interests (15.85% each), and types of benefits and program implementers (14.63% each).

Stakeholders (academics, DLH, environmental NGOs, B3 waste corporations, local media, and affected residents) argued that decision-making remains centralized under the national government, leaving local authorities with limited discretion and making local supervision rigid. This is problematic given Dumai's large volume of B3 waste from numerous palm oil mills along the coast.

Alarmingly, field observations and multiple informants (particularly from NGOs, local media, and affected residents) reported that improper disposal, including the sale of B3 waste to unauthorized third parties and its dumping on public or community land, is not an isolated incident but a recurring practice. While a precise, city-wide quantification of illegal dumping volume was beyond the scope of this study, convergent evidence from interviews across stakeholder groups and observational data from several sites indicates the practice is sufficiently widespread to be a recognized and normalized bypass of the formal waste management system. This normalization points to systemic enforcement failure rather than sporadic violations. The economic incentive for companies to avoid proper disposal costs and the ready market for untreated waste as cheap fill material perpetuate this cycle. The scale of the problem, therefore, is qualitatively assessed as significant, directly undermining the regulatory framework and contributing to observable environmental degradation in affected communities.

Regarding allocated resources, most informants stated that

the program suffers from inadequate institutional capacity, budget, and skilled human resources. Local communities have even used B3 waste, such as spent bleaching earth, as fill material without understanding its hazards, partly because neither DLH nor local companies have provided sufficient information or outreach.

The expected level of change and affected interests remain low because public involvement is limited and collaboration between government and stakeholders is weak. The absence of a specific local regulation (Perda/Perwako) on B3 waste management has resulted in poor coordination between central and local policies and low public attention to the issue. Consequently, the affected interests are mainly visible through harmful practices like unauthorized waste sales and unsafe dumping on community lands.

Similarly, the types of benefits and program implementers remain unclear due to the absence of a comprehensive local regulation. The benefits have not been widely felt by the public, and program implementation remains fragmented and overlapping. Greater collaboration is needed among government agencies, the private sector, academia, and local communities.

Overall, the analysis of the policy content dimension indicates that Dumai City Regulation No. 5 of 2017 remains ineffective due to the presence of several structural and operational weaknesses. These shortcomings hinder the program from achieving its intended goals and create uncertainty in its implementation. To address this issue, there is an urgent need for the local government to formulate and enact a specific local regulation or a mayoral decree that directly governs the B3 waste control program. Such a legal framework would not only clarify operational guidelines but also promote more inclusive and sustainable participation from all relevant stakeholders, thereby enhancing the program's effectiveness.

3.2 Implementation of Dumai City Regulation No. 5 of 2017 from the policy context

The success of public policy also depends on implementation dynamics, which in this study were assessed across three aspects: (1) power, interests, and strategies of actors involved, (2) institutional and regime characteristics, and (3) compliance and responsiveness. The matrix coding query below presents stakeholder perspectives on the first aspect.

As shown in Table 4, DLH emerged as the most dominant actor (18.48%), emphasizing that implementation hinges on the capacity and commitment of local human resources, especially within DLH, in coordination with the Riau Provincial DLHK. Collective commitment from companies, academics, media, and the public is essential for effective B3 waste management and for preventing illegal dumping [8, 18]. Weak human resources, particularly the shortage of environmental inspectors and trained staff, enable illegal practices and weaken enforcement [8]. Some actors attempt to reduce pollution by referring to Articles 77(1–2) of Dumai City Regulation No. 5 of 2017, which assigns oversight responsibilities to the mayor and the local environmental agency, including training and establishing standards and procedures.

Table 4. Matrix coding query on the power, interests, and strategies of actors involved in the B3 waste control program

Aspects	Environmental Agency (%)	B3 Waste Corporations (%)	Environmental NGOs (%)	Affected Residents (%)	Academics (%)	Local Media (%)
Power, interests, and strategies	18.48	15.18	16.83	15.51	17.16	16.83

Source: Results of analysis using NVivo 12 Plus, 2025

Note: Percentages reflect the proportion of coded references attributed to each stakeholder group within the matrix query for this specific theme (Power, Interests, and Strategies). A higher percentage indicates that the group's interview responses contributed more frequently to the discussion and identification of issues under this theme, highlighting their particular perspective or the salience of the issue to them. Statistical significance testing does not apply to this qualitative, thematic analysis.

Table 5. Matrix coding query on institutional and regime characteristics in the B3 waste control program

Aspects	Environmental Agency (%)	B3 Waste Corporations (%)	Environmental NGOs (%)	Affected Residents (%)	Academics (%)	Local Media (%)
Institutional and regime characteristics	15.69	16.34	16.99	16.34	16.01	18.63

Source: Results of analysis using NVivo 12 Plus, 2025

Note: Percentages reflect the proportion of coded references attributed to each stakeholder group within the matrix query for this specific theme (Institutional and Regime Characteristics). A higher percentage indicates that the group's interview responses contributed more frequently to the discussion and identification of issues under this theme, highlighting their particular perspective or the salience of the issue to them. Statistical significance testing does not apply to this qualitative, thematic analysis.

Table 6. Matrix coding query on compliance and responsiveness in the B3 waste control program

Aspects	Environmental Agency (%)	B3 Waste Corporations (%)	Environmental NGOs (%)	Affected Residents (%)	Academics (%)	Local Media (%)
Compliance and responsiveness	22.56	18.42	10.53	18.05	18.42	12.03

Source: Results of analysis using NVivo 12 Plus, 2025

Note: Percentages reflect the proportion of coded references attributed to each stakeholder group within the matrix query for this specific theme (Compliance and Responsiveness). A higher percentage indicates that the group's interview responses contributed more frequently to the discussion and identification of issues under this theme, highlighting their particular perspective or the salience of the issue to them. Statistical significance testing does not apply to this qualitative, thematic analysis.

However, the regulation lacks operational clarity, particularly regarding the assignment of roles and responsibilities, creating a substantial gap between policy formulation and execution [18]. This gap is further underscored by sectoral analyses revealing a misalignment between the stated policy framework and its practices at industrial sites and public institutions. These findings highlight the urgent need for clearer operational procedures and better resource allocation to support implementation [19, 20]. The matrix coding query also offered insights by examining institutional and regime characteristics that influence how the policy operates within the governance structure.

As shown in Table 5, Local media were the most dominant informants (18.63%), noting that implementation is hindered by institutional arrogance, the reluctance of local agencies to coordinate with Riau Provincial DLHK, and apathy among some companies. Many actors lack a clear understanding of the obligations and prohibitions outlined in the regulation, resulting in an uncooperative and non-conducive implementation environment.

The identification of "institutional arrogance" and coordination reluctance points to deeper systemic causes rooted in conflicting incentives and governance structures. Interviews suggest that local agencies, such as the DLH, operate under dual pressures: they are evaluated on formal compliance metrics (e.g., report submission) by higher levels of government, while simultaneously facing intense local political and economic pressure to avoid stringent enforcement that could alienate major taxpayers and employers like palm oil companies. This creates a perverse incentive where inaction or superficial coordination is the safer bureaucratic choice. Furthermore, the lack of integrated performance indicators that reward inter-agency collaboration or environmental outcomes (as opposed to output-based targets) fosters a siloed mentality. The "arrogance" or reluctance to coordinate with provincial authorities (DLHK) may stem from a desire to maintain autonomy, avoid oversight that could reveal implementation failures, or a resource rivalry where collaboration is seen as a burden rather than a mutual benefit. Addressing these issues requires aligning institutional rewards with collaborative, outcome-oriented environmental governance. Lastly, the matrix coding query explored compliance and responsiveness.

As shown in Table 6, DLH (22.56%), B3 waste corporations (18.42%), academics (18.42%), and affected residents (18.05%) were the dominant informants on this aspect. They stressed that compliance remains low and oversight weak because DLH lacks strategic authority. Article 79(1) of the regulation states that the mayor oversees B3 waste management through DLH and DPRD, while Article 80(2) states that procedures follow national legislation. In practice, regulations often lack clear enforcement mechanisms, making oversight and accountability difficult. Studies on Indonesian governance consistently emphasize the need to strengthen enforcement capacity, establish clearer procedures, and enhance agency capabilities [21, 22]. The commonly used clause “in accordance with applicable laws” is also problematic, as it remains vague in a country with diverse local contexts, highlighting the importance of locally tailored approaches grounded in local norms and community participation [23]. Effective responses should combine legislative updates with public education and community-based support to address regional differences and promote sustainable compliance [22-24].

Overall, the policy context dimension shows that implementation remains suboptimal due to the absence of a specific local regulation, weak institutional commitment, and complex dynamics related to actor power, institutional characteristics, and compliance. Stronger regulations, commitment, trust, communication, and collaboration are urgently needed to improve the effectiveness of B3 waste management in Dumai.

3.3 Synthesis of evidence: Academic contributions and future directions

This study shows that Dumai City Regulation No. 5 of 2017 remains ineffective due to flaws in policy content and context. Centralized decision-making limits local discretion, while inadequate resources, institutional rigidity, conflicting interests, and weak compliance enable unsafe B3 waste practices that endanger public health and the environment. This supports the view of Grindle and Thomas [17] that policy design shapes outcomes, yet unlike studies focusing only on design [9, 10] or impacts [11, 12], this study shows regulations fail without multi-actor commitment, clear roles, and enforceable mechanisms.

Academically, it integrates environmental governance and consumer protection law, showing how ineffective regulation undermines the public’s legal right to a healthy environment. This rarely used lens marks its novelty, shifting discourse from technical compliance toward environmental justice. It aligns with [15, 16, 25] that responsive governance and trust are as vital as rules. Trust enables regulator–industry collaboration, while transparency and accountability sustain public trust [25, 26]. Participatory networks build trust [27], clear roles reduce conflict [28], and perceived transparency enhances citizen trust [25]. SOPs also support trust during crises [29].

This study fills a gap by showing how policy content and context interact in decentralized systems. In high-pressure settings like Dumai, economic imperatives often overshadow environmental priorities [30]. Governance tools like UKL-UPL and Environmental Management Systems clash with project economics [31, 32], while multi-stakeholder frameworks like ISPO still show prioritization gaps [30]. Dumai’s history as an oil-based company town shaped policies that sideline safeguards [33], and palm oil investments often prioritize profit over protection [34]. Broader discourse urges stronger state–public collaboration.

Mapping stakeholder views further reveals that power asymmetries and institutional silos weaken collective accountability. Power imbalances skew participation and legitimacy [35, 36], while silos fragment coordination, undermining shared metrics [37]. Environmental justice theory highlights the need to amplify marginalized voices and redistribute governance burdens [38]. Similar governance gaps erode accountability in the Niger Delta e-waste management [39]. Addressing this requires cross-sector reforms to reduce imbalances, dismantle silos, and restore accountability [36, 37, 40].

Practically, three steps are vital: establish a local regulation with clear operational and enforcement frameworks; strengthen institutional capacity, budgets, and multi-actor collaboration; and shift oversight from compliance-based reporting to participatory monitoring. These measures can align Dumai’s hazardous waste governance with SDG 6 and

SDG 12. Future studies should use longitudinal or mixed-method approaches to track institutional behavior and compare regions to advance governance theory and guide policy innovation.

4. CONCLUSIONS

The implementation of Dumai City Regulation No. 5 of 2017 on the management of hazardous and toxic (B3) waste by palm oil companies has proven to be ineffective and inconsistent. Compliance levels remain low, as many companies do not follow the prescribed procedures for handling and disposing of B3 waste. This regulatory weakness has produced negative consequences for both the environment and surrounding communities, particularly concerning public health and quality of life. From the perspective of consumer protection law, the community's legal right to a healthy environment has not been adequately fulfilled. This study contributes new insights by integrating the environmental governance perspective with the legal framework of consumer protection to evaluate the implementation of environmental regulation at the subnational level. Unlike previous studies that have largely focused on either policy formulation [25] or environmental impacts in general [24], this research highlights the persistent gap between regulatory design and field-level execution. It demonstrates how centralized decision-making, insufficient resource allocation, institutional rigidity, low public participation, and limited enforcement power undermine the effectiveness of B3 waste governance under decentralized administration.

The findings underscore the need for the Dumai City Government to adopt a more comprehensive approach by establishing a dedicated local regulation (Perda/Perwako) for B3 waste management. This should be accompanied by clear operational guidelines, structured oversight mechanisms, and strict sanctioning frameworks to strengthen compliance. Moreover, implementation requires sustained capacity building, adequate budget support, and robust collaboration among government agencies, industry actors, civil society, academia, media, and affected communities. Strengthening these components will not only enhance compliance and accountability but also align local practices with Sustainable Development Goals, particularly Goal 6 (Clean Water and Sanitation) and Goal 12 (Responsible Consumption and Production). Ultimately, this study emphasizes that effective B3 waste management is not solely about legal instruments but also about building an ecosystem of shared accountability, public trust, and continuous institutional commitment. This perspective advances the discourse on environmental governance in decentralized settings and offers practical guidance for improving subnational environmental regulation in other palm-oil-producing regions.

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