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A Systematic Literature Review on the Role of Local Government in Cross-Sectoral Waste Management Integration in Jakarta, Indonesia

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ABSTRACT: This article presented a systematic literature review (SLR) to examine the role of local government in the cross-sectoral integration of waste management in the Special Capital Region of Jakarta. Waste management in Jakarta evolved into a complex governance issue involving public services, environmental health, spatial planning, and aquatic pollution control. This study synthesized scientific publications and policy documents published over the previous ten years using a structured review approach. The findings revealed that local governments performed four main roles: regulatory, coordinative, service delivery, and supervisory/accountability. However, policy implementation remained predominantly oriented toward downstream treatment rather than source reduction. Key policy instruments identified included plastic restriction regulations, extended producer responsibility (EPR) schemes, community-based initiatives such as waste banks, and the development of waste processing infrastructure, including refuse-derived fuel (RDF) facilities. Major constraints included limited institutional capacity, weak inter-agency coordination, inconsistent enforcement, and low public compliance. The review highlighted that strengthening cross-sectoral integration required a strategic shift toward measurable source reduction, optimization of economic instruments and EPR mechanisms, integration of land-based waste management with marine litter prevention, and the development of data-driven monitoring systems to support sustainable metropolitan governance.

KEYWORDS: Local government; cross-sectoral; waste management; Jakarta

1. Introduction

The waste problem in metropolitan areas such as Jakarta evolved into a strategic urban governance issue that directly impacted basic public services, environmental health, spatial planning, and ecosystem sustainability. The high daily waste generation, reaching thousands of tons, reflected the urgency of strengthening policies and the capacity of an integrated waste management system from upstream to downstream. The pressures of urbanization, economic growth, and changing consumption patterns increased the burden on the waste management system, such that the waste problem could no longer be understood as a purely technical issue, but rather as a matter of public policy and governance [1, 2].

The complexity of this issue was exacerbated by the cross-sectoral nature of governance, which involved various actors and institutional frameworks. The literature confirmed that urban waste management required the integration of policies, institutions, funding, and data systems across agencies to ensure effective and integrated services from upstream to downstream [2]. However, practices in developing countries showed that inter-sectoral coordination, regulatory–program consistency, and cross-agency monitoring and evaluation mechanisms remained major structural challenges [1].

In the context of policy implementation, various studies showed a gap between policy design and implementation in the field. Aditya et al. found that Jakarta's waste management for the 2019–2023 period was still predominantly oriented toward downstream handling, while source reduction and sorting were not yet optimal [3]. This pattern was in line with global findings that identified limitations in operational funding, human resource capacity, sorting infrastructure, and weak institutional coordination as factors inhibiting the transition to a more sustainable and circular system [1]. Public pressure and the global agenda regarding plastic pollution also strengthened demands on governments to improve the effectiveness, transparency, and integration of policies from upstream to downstream [4].

From an empirical literature perspective, previous studies tended to be partial, such as studies on the implementation of waste policies [3], community participation and waste banks [5], marine waste management and waste leakage into waters [6], as well as actor models for coastal plastic waste management [7]. Although these studies were important, there had not been a comprehensive study that mapped the role of local governments across the entire chain of Jakarta's waste management policies from upstream to downstream, including agenda formulation, regulatory design, policy instruments, implementation capacity, cross-sector coordination, and performance in reducing and controlling waste leakage into waters.

Therefore, this article specifically filled this research gap by presenting a literature synthesis that positioned local governments as key actors across the entire chain of waste management policies and governance in Jakarta, and integrated the dimensions of public policy, institutions, regulatory instruments, multi-stakeholder collaboration, and implementation dynamics into a single analytical framework from upstream to downstream.

2. Materials and Methods

2.1. Study design (Systematic Literature Review Framework)

This study employed a systematic literature review (SLR) to better understand how local governments contributed to cross-sectoral waste management integration in Jakarta. The SLR approach was chosen because it allowed a more structured and transparent synthesis of findings from various studies. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, which consisted of four main stages: identification, screening, eligibility, and inclusion. This framework helped ensure that only relevant studies were selected through a transparent process, while also reducing potential selection bias in the review process. Through this approach, the study sought to provide a more comprehensive understanding of governance dynamics and policy instruments in urban waste management.

Furthermore, the SLR design enabled the integration of fragmented findings from previous studies into a coherent analytical framework, particularly in addressing the complexity of cross-sectoral issues involving environmental governance, public policy, and urban management. This approach was particularly relevant given that existing studies on Jakarta's waste management were often partial and sector-specific, thereby requiring a holistic synthesis to capture upstream–downstream integration and multi-actor interactions. The study selection process was conducted following the PRISMA framework, which included identification, screening, eligibility, and inclusion stages. A total of 170 records were initially identified from database searching and other sources. After removing duplicates and applying screening criteria, 28 studies were deemed eligible and were included in the final synthesis. The detailed process of study selection was illustrated in Figure 1.

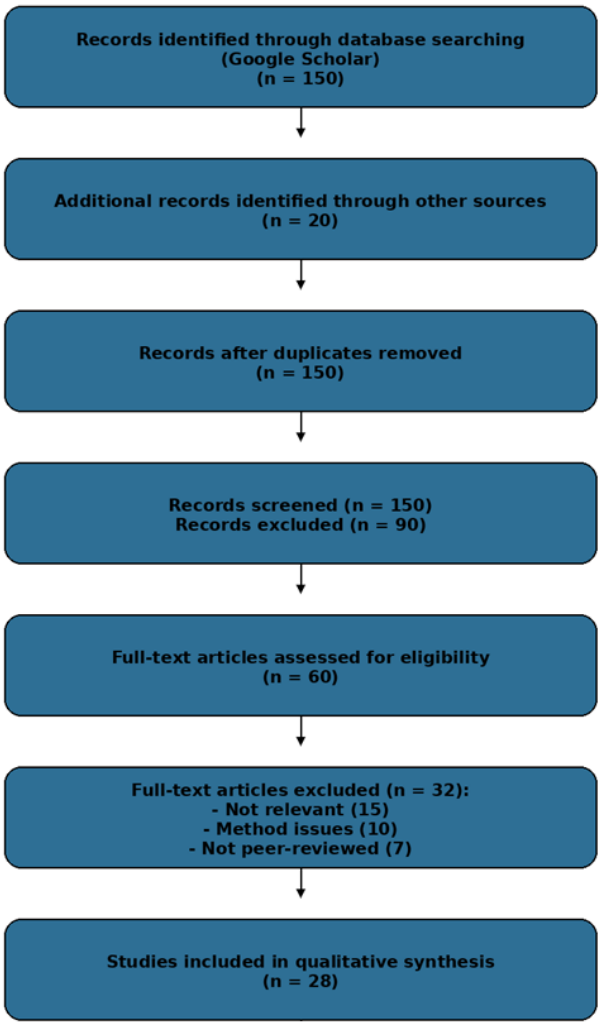

Figure 1. PRISMA flow diagram of the study selection process.

2.2. Data sources and search strategy.

The data used in this study were derived from a combination of scientific literature and policy-related documents obtained from national and international sources. The primary database used for literature retrieval was Google Scholar, which provides broad access to peer-reviewed journal articles, conference proceedings, and scholarly publications relevant to the research topic. In addition to Google Scholar, complementary searches were conducted using databases

such as Scopus and ScienceDirect to enhance coverage and ensure the inclusion of high-quality indexed publications. The search strategy employed a set of predefined keywords and their combinations to ensure comprehensive coverage of the topic. These keywords included “waste management Jakarta”, “local government role”, “cross-sectoral integration”, and “extended producer responsibility”. Boolean operators (AND, OR) were used to refine search results and improve relevance. To ensure the currency and policy relevance of the analysis, the search was limited to publications from the last ten years. However, seminal and foundational theoretical works were also included to strengthen the conceptual framework of the study [8]. In addition to academic sources, relevant policy documents were incorporated to capture regulatory and institutional dimensions of waste management practices. The search process was conducted iteratively, meaning that initial findings were further expanded through backward and forward citation tracking to identify additional relevant studies. This strategy ensured that the literature coverage was both comprehensive and representative of the research domain.

2.3. Inclusion and exclusion criteria.

The selection of literature was conducted using a purposive sampling approach based on clearly defined inclusion and exclusion criteria to ensure the relevance, quality, and consistency of the reviewed studies. The inclusion criteria consisted of scientific publications such as journal articles, conference proceedings, research reports, and official policy documents; studies directly related to waste management, the role of local government, or cross-sectoral integration; publications within the last ten years to ensure up-to-date analysis; and studies with clearly defined methodologies, sufficient data, and credible findings. Conversely, the exclusion criteria included non-peer-reviewed publications and grey literature lacking academic rigor; opinion-based articles without empirical or analytical grounding; duplicate publications identified during the screening process; and studies that were not directly relevant to the research objectives. To strengthen methodological rigor, priority was given to peer-reviewed journal articles, particularly those indexed in Scopus or published in reputable academic journals. Studies with clear methodological approaches and empirical evidence were prioritized to ensure the reliability and validity of the findings. The screening process was conducted in multiple stages, beginning with title and abstract screening, followed by full-text assessment to determine eligibility. This process ensured that only high-quality and relevant studies were included in the final synthesis [8, 9]. After completing the screening and eligibility stages, a total of 28 studies were included in the final analysis. The application of these criteria contributed to reducing selection bias and enhancing the validity of the review findings.

2.4. Data extraction and analysis.

Data extraction was conducted systematically by identifying and recording key information from each selected study. The extracted data included research objectives, methodological approaches, key findings, and policy implications. This process was carried out using a structured data extraction framework to ensure consistency, transparency, and replicability across all reviewed documents. The analysis process involved three main stages. First, data reduction was conducted to filter and organize relevant information, eliminating redundant or less relevant data. Second, data categorization was performed by grouping findings into thematic categories based on recurring patterns in the literature. These themes included regulatory roles, institutional coordination, economic instruments and extended producer

responsibility, community participation, and the integration of land-based waste management with marine litter prevention.

Third, data synthesis was carried out to integrate findings across studies and identify broader trends, relationships, and research gaps. The synthesis process emphasized comparative analysis and thematic interpretation rather than simple summarization, enabling the identification of systemic challenges and opportunities in waste management governance. This analytical approach allowed the study to generate a comprehensive and evidence-based understanding of cross-sectoral integration in Jakarta's waste management system and supported the development of conceptual models and policy recommendations grounded in empirical and theoretical insights.

In addition to qualitative synthesis, this study also incorporated basic descriptive quantitative analysis to enhance methodological rigor. This included the calculation of the frequency of themes, the distribution of studies across categories, and temporal trends of publications over the selected period. These quantitative insights complemented the qualitative findings by providing measurable patterns in the literature, thereby strengthening the validity, transparency, and robustness of the overall analysis.

3. Results and Discussion

A total of 28 studies were included in the final synthesis. A descriptive analysis was conducted to identify the distribution of studies based on publication year, thematic focus, and policy instruments discussed. In terms of temporal distribution, the number of publications showed an increasing trend over the last decade, indicating growing academic and policy attention toward urban waste management and environmental governance in Jakarta and similar metropolitan contexts. The thematic analysis showed that most studies tended to focus on community-based waste management (e.g., waste banks), policy implementation, and marine debris management. Meanwhile, studies focusing on economic instruments such as extended producer responsibility (EPR) and fiscal policies remained relatively limited, suggesting a gap in the literature. Furthermore, the distribution of studies across thematic categories indicated that the majority of research was still concentrated on downstream waste management practices, while fewer studies addressed upstream strategies such as waste reduction and behavioral change. This finding supported the overall conclusion that waste management policies remained predominantly oriented toward handling rather than prevention.

3.1. Configuration of the role of regional governments in cross-sector integration of waste management in the Special Capital Region of Jakarta.

A literature synthesis showed that the role of local governments in waste management in the Special Capital Region of Jakarta was multi-functional and cross-sectoral, particularly because waste issues involved basic public services, environmental health, spatial planning, and water pollution control. In this context, local governments generally performed four main roles: regulatory, coordinating, service delivery, and oversight/accountability (Figure 2). First, the regulatory role was evident in the establishment of regional policy standards and directions, which served as a reference for regional officials and stakeholders. Implementation literature in Jakarta confirmed that regional policies served as a formal framework, but their effectiveness was determined by the clarity of standards, targets, and consistency of implementation across agencies [3, 10].

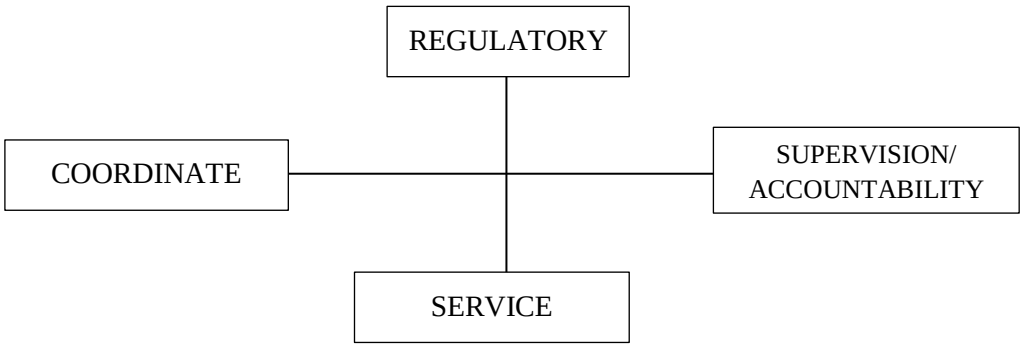

Figure 2. Model of four roles of local government in waste management.

Second, a coordinating role emerged as a dominant need because waste management was not solely the responsibility of the environmental agency, but also involved regional agencies in trade, industry, education, transportation, spatial planning, and regional authorities. A study on the implementation of marine waste management policies in Muara Angke showed that coordination across actors and levels of government influenced the achievement of policy implementation and the response of coastal communities [11].

Third, service delivery played a prominent role in the collection, transportation, and management of facilities, which in practice were heavily influenced by resource capacity and operational governance. Research findings in Jakarta confirmed a tendency toward downstream (handling) approaches rather than source reduction, indicating that service functions remained the focus of implementation rather than behavioral and system transformation functions [3, 12].

Fourth, the role of oversight and accountability was evident in the need to monitor service performance, business actor compliance, and cross-agency program evaluation. E-government literature showed that data integration and multi-platform applications had the potential to strengthen public service monitoring, which was relevant to strengthening data-based oversight mechanisms in waste management [13].

Thus, cross-sector integration, as found in the literature, did not stop at formal coordination but rather required alignment of targets, division of labor, and data systems across regional agencies. Studies of waste management collaboration in other cities in Indonesia showed that collaborative governance and cross-actor leadership could strengthen program performance, particularly when incentives, roles, and interdependencies between parties were clearly mapped [14, 15]. This perspective was aligned with Jakarta's needs, considering the complexity of actors and the high scale of waste generation.

Despite increasing policy awareness regarding waste reduction, the persistence of downstream-oriented approaches could be attributed to several structural factors. First, waste management systems in metropolitan areas were historically designed around collection and disposal services, making infrastructure-based solutions more immediately implementable. Second, upstream interventions such as behavioral change and producer responsibility required longer time horizons, cross-sector coordination, and stronger regulatory enforcement, which were often more difficult to achieve. This indicated that the dominance of downstream strategies was not merely a policy preference but reflected institutional path dependency and governance constraints. As a result, shifting toward upstream-oriented waste management required not only new policies but also transformation in institutional design, incentive structures, and stakeholder coordination.

3.2. Mapping of dominant policy instruments used.

The synthesis results showed that the policy instruments that most frequently appeared in the urban waste management literature (including Jakarta) could be grouped into regulatory instruments, economic instruments, institutional–collaborative instruments, community-based instruments, and technology/infrastructure instruments (Table 1). Regulatory instruments included plastic restrictions, sorting requirements, environmentally friendly facility requirements, and regional implementation guidelines. A study on the implementation of the mandatory use of environmentally friendly shopping bags in Jakarta showed that the effectiveness of regulatory instruments was influenced by consistent supervision, business readiness, and public acceptance [16]. At the same time, a study on the implementation of household waste management policies in Jakarta (compared with other regions) confirmed that regulations required the support of implementing mechanisms and the strengthening of compliance systems so that they did not remain merely as policy documents [17].

Table 1. Jakarta waste management policy instrument matrix.

Policy Instrument	Form	Primary Function	Policy Impact	Key Challenges
Regulatory Instrument	Governor Regulations; Presidential Regulations	Regulatory control and institutional oversight	Improved regulatory compliance	Weak enforcement mechanisms
Economic Instrument	Plastic excise tax; Extended Producer Responsibility (EPR) scheme	Incentive-based behavioral modification	Reduction in plastic consumption	Industrial resistance and compliance costs
Community-Based Instrument	Waste bank programs	Community engagement and participatory governance	Enhanced waste segregation at source	Institutional sustainability and capacity constraints
Infrastructure Instrument	Refuse-Derived Fuel (RDF) facilities; TPS3R (Reduce, Reuse, Recycle-based Processing Sites)	Waste diversion from landfills and processing optimization	Increased system efficiency	Downstream processing dependency

Economic instruments in the literature typically related to disincentives for plastic consumption, service costs, and extended producer responsibility. Studies on plastic excise policies positioned fiscal instruments as one option for changing consumption behavior, but their effectiveness was determined by tariff design and implementation commitment [18]. At a more systemic level, the extended producer responsibility literature emphasized that the success of such policies was determined by institutional design, cost-sharing arrangements, collection and recycling targets, and monitoring mechanisms [19–21]. This was particularly relevant for Jakarta, where the pressure from packaging and plastic waste required instruments that bound producers, rather than merely encouraging changes in consumer behavior.

Institutional–collaborative instruments were evident through the strengthening of multi-stakeholder cooperation, collaborative community programs, and cross-agency coordination. Studies on dynamic governance in waste management in other cities showed that policy adaptation, institutional learning, and community engagement could enhance the resilience of waste management systems [15]. Community-based instruments, particularly waste banks, were also dominant in the Indonesian literature. Findings in South Jakarta indicated that perceptions, motivation, and institutional support were associated with household participation [5]. In other areas, evaluations of waste bank programs showed the importance of sustainability

indicators and institutional performance [22]. This indicated that community-based instruments were effective when local governments not only launched programs but also ensured logistical support, incentives, and integration with transportation and processing systems.

Technological and infrastructure instruments were evident in the trend toward strengthening medium- to large-scale processing facilities, such as refuse-derived fuel. An analysis of the implementation of a refuse-derived fuel trial in Rorotan showed that the technological approach required strong implementation governance, including input readiness, impact management, and inter-agency coordination [23]. Global literature on waste management confirmed that downstream technologies were ineffective without source reduction and sorting, as the quality of incoming materials determined both effectiveness and operational costs [24, 25].

The increasing reliance on technological solutions, such as refuse-derived fuel (RDF), also raised important trade-offs in waste management strategy. While RDF facilities contributed to reducing landfill dependency and improving waste processing efficiency, they could inadvertently reinforce downstream-oriented approaches if not accompanied by strong upstream reduction policies. This created a potential policy dilemma: investments in large-scale processing infrastructure could generate structural dependency on continuous waste supply, which might conflict with long-term goals of waste reduction and circular economy principles. Therefore, technological solutions needed to be positioned as complementary rather than primary strategies, ensuring alignment with source reduction and waste minimization objectives.

The distribution of policy instruments presented in Table 1 indicates that regulatory and infrastructure-based approaches remain the most dominant strategies in Jakarta's waste management system. Regulatory instruments provide a formal framework for controlling waste-related activities, while infrastructure investments, such as RDF facilities and TPS3R, reflect a strong emphasis on downstream waste handling. However, the relatively limited role of economic instruments, particularly extended producer responsibility (EPR), suggests that upstream intervention strategies are not yet fully optimized. This imbalance indicates that policy implementation is still oriented toward waste treatment rather than prevention, highlighting the need for stronger integration of economic and behavioral instruments to support sustainable waste reduction at the source.

3.3. Barriers and supporting factors for implementation from the perspective of public administration and environmental policy.

The results indicated that barriers to waste management implementation in metropolitan areas were primarily concentrated in resource capacity, institutional design, cross-actor coordination, and public compliance (Table 2). The implementation study in Jakarta for the 2019–2023 period revealed challenges related to resource constraints and the characteristics of implementing organizations, as well as a stronger program bias toward downstream approaches rather than reduction [3]. Research on the implementation of waste policy in South Jakarta also highlighted that increasing waste volume and a weak culture of cleanliness were significant obstacles, indicating that policy instruments required a consistent behavior change strategy [10]. Similar findings were observed in studies conducted in buffer zones, which emphasized that policy implementation was strongly influenced by the environmental agency's capacity in planning, operational management, and institutional coordination [26].

Table 2. Matrix of barriers and supporting factors for implementation (public administration and environmental policy perspective).

Dimension	Category	Substantive Description	Key Findings	References
Barriers	Resource Capacity	Limitations in human resources, funding, and operational capacity of implementing organizations	Implementation remains downstream-oriented; weak source reduction; organizational capacity not yet adaptive	[3, 26]
	Institutional Design	Organizational structure does not adequately support upstream–downstream integration	Fragmentation of authority; weak structural coordination design	[3, 19]
	Cross-Actor Coordination	Weak inter-agency and cross-sectoral collaboration	Policies are ineffective without operational coordination mechanisms	[7, 11]
	Public Compliance	Low sanitation culture and waste segregation behavior	Behavioral change has not been fully internalized	[10]
	Upstream–Downstream Integration	Land-based waste management is not integrated with river and marine systems	Rivers serve as primary pathways for marine plastic leakage	[6, 27]
	Plastic Production Pressure	Increasing global plastic production	Growing burden on urban systems and continued environmental leakage	[4]
Enabling Factors	Institutional Capacity	Leadership and collaborative governance arrangements	Leadership roles and institutional design strengthen collective action	[14]
	Multi-Stakeholder Collaboration	Synergy among government, communities, and private sector	Effective solutions require operational-not merely ceremonial-collaboration design	[7]
	Community Participation	Supportive systems, incentives, and institutional arrangements	Participation increases when supported by facilities and incentives	[5, 22]
	Information Systems	Digitalization and data integration	More effective monitoring, evaluation, and service oversight	[13]
	Public Health Legitimacy	Impacts of waste on public health	Waste management framed as a public health protection agenda	[28]

Cross-sectoral barriers were also strongly evident in the issue of marine debris. A study in Muara Angke showed that marine debris management policies faced limitations in implementing action plans, challenges in public awareness, and coordination. Therefore, policy effectiveness was determined not only by the presence or absence of regulations but also by the effectiveness of cross-agency and cross-actor implementation [11]. From an actor-mapping perspective, research in the coastal areas of Jakarta showed that central and regional governments were actors with high influence but also high dependence on other actors; this indicated that solutions required collaborative design and operational, rather than merely ceremonial, coordination mechanisms [7].

Global literature supported the explanation that these barriers were structural in nature. Rivers were identified as the primary pathway for plastic emissions to the ocean, making upstream and cross-sectoral interventions involving housing, drainage, sanitation, industry, and trade a policy necessity that could not be addressed by a single agency [27]. For Jakarta and its

surrounding areas, scientific evidence pointed to seasonal variations and river estuaries as key sources of land-based debris entering the ocean, which in policy terms required the integration of land-based waste management with leakage control in river and drainage systems [6]. Literature on global plastic production and fate explained that the massive production of plastic increased the burden on management systems in large cities, and without robust policy instruments, environmental leakage would continue [4].

Factors supporting consistent implementation were identified in three main forms. First, strengthening institutional capacity and collaborative governance was essential. Studies on waste management collaboration emphasized the importance of leadership, incentives, and clearly defined roles in encouraging effective collaboration across actors [14]. Second, support for community participation needed to be underpinned by systemic mechanisms. Household participation increased when there was strong institutional support and clear incentives [5, 22]. Third, strengthening information and monitoring systems was critical. E-government literature showed that application development and data integration could improve the quality of public services, which translated into Jakarta's need to enhance monitoring of waste reduction, sorting performance, and business compliance [13]. Furthermore, public health literature warned that poor waste management increased health risks, indicating that strengthening policies was not only an environmental agenda but also a public health protection priority [28].

As shown in Table 2, implementation barriers in Jakarta's waste management system were structural and systemic rather than merely technical. Key constraints such as limited resource capacity, fragmented institutional design, weak cross-sectoral coordination, and low public compliance were closely interconnected and reinforced one another. For instance, weak institutional arrangements often led to poor coordination, which in turn reduced policy consistency and public adherence to waste management practices.

On the other hand, the most critical enabling factors lay in strengthening institutional capacity and fostering collaborative governance across actors. These factors played a central role in improving coordination mechanisms, enhancing policy implementation, and supporting sustained behavioral change at the community level. In addition, system-based public participation and the integration of information systems contributed to more effective monitoring and accountability.

These findings suggested that improving waste management in Jakarta required not only technical solutions but also systemic institutional reform and stronger cross-sectoral collaboration. The interaction between barriers and enabling factors highlighted that governance capacity was the key determinant of effective and sustainable metropolitan waste management. Overall, the findings indicated that waste management challenges in Jakarta were fundamentally governance-related rather than purely technical, emphasizing the need for institutional reform and cross-sectoral policy integration.

3.4. Research agenda and policy implications for strengthening source reduction, participation, and prevention of leakage to waters.

Based on the literature findings, three priority policy agendas were identified to strengthen cross-sectoral integration in Jakarta. First, the strategy needed to be repositioned from a

dominant downstream management approach toward measurable reduction at the source. Implementation studies in Jakarta indicated that downstream focus remained dominant [3], while studies on the evolution of waste management in developing countries confirmed that a paradigm shift required changes in policy, cost management, and the allocation of actor roles [25]. Consequently, local governments needed to prioritize sorting and reduction targets as cross-agency performance indicators, rather than limiting them to specific agencies.

Second, producer responsibility and economic instruments needed to be strengthened to ensure that the management burden was not borne solely by local governments and households. OECD literature emphasized that effective extended producer responsibility required transparent targets, financing, and reporting systems [19, 20], as well as careful consideration of institutional design and market dynamics [21]. At the local level, fiscal instruments such as plastic excise taxes required further study in terms of tariff design and implementation readiness to influence consumption behavior [18]. A key research agenda was to examine the suitability of extended producer responsibility design and fiscal instruments within Jakarta's urban economic structure, including the retail supply chain and packaging manufacturing sectors.

Third, the integration of land-based waste management with the prevention of leakage into waterways needed to be implemented as a single governance framework. Scientific evidence on the contribution of river estuaries in Jakarta [6] and the role of rivers as major pathways for plastic emissions [27] suggested that waste management programs had to be integrated with drainage policies, river normalization, management of densely populated areas, and control of plastic waste sources. Studies in Muara Angke showed that awareness and policy implementation in coastal areas required intervention designs that addressed both upstream and downstream aspects [11].

From a research perspective, there was a need to strengthen studies examining the most effective cross-sectoral coordination models for metropolitan areas, the effectiveness of combined regulatory, economic, and community-based instruments in encouraging household sorting, the evaluation of plastic restriction and extended producer responsibility policies on landfill load and river leakage, and the management of processing technologies such as refuse-derived fuel to avoid downstream dependency while remaining compatible with source reduction strategies [23, 24]. In practice, strengthening cross-sectoral integration also required operational support for collaborative governance, as demonstrated by studies in other cities [14, 15].

Compared with best practices in other metropolitan regions, effective waste management systems typically prioritized upstream interventions, including strict waste segregation policies, enforcement of extended producer responsibility, and economic instruments that incentivized waste reduction. Cities that successfully reduced landfill dependency tended to integrate regulatory, economic, and behavioral instruments within a coherent governance framework. In contrast, Jakarta's approach remained relatively fragmented, with stronger emphasis on downstream management and infrastructure development. This comparison suggested that achieving sustainable waste governance required a more balanced integration of upstream and downstream strategies, supported by consistent policy enforcement and cross-sectoral coordination.

3.5. Conceptual model of upstream-downstream cross-sector integration.

Based on the literature synthesis, which connects the role of local government, policy instruments, multi-stakeholder actors, and the impact of policies from upstream to downstream, two conceptual models of waste management integration in Jakarta were formulated as follows:

3.5.1. Upstream–downstream cross-sector integration model.

The Upstream–Downstream Cross-Sector Integration Model depicted waste management as an integrated policy system that connected all stages of the service chain, from households and producers as sources of waste generation, through sorting at source, integrated collection, processing via treatment facilities such as TPST and RDF, to the disposal of residues at the final disposal site (TPA). This flow emphasized that system effectiveness was not determined by a single service point, but rather by the coherence between stages across the entire management chain.

At the upstream stage, households and producers were positioned as key actors in reducing waste generation and sorting at source. This stage formed the foundation for the effectiveness of the entire system, as the quality of sorting determined collection efficiency, the effectiveness of processing technology, and the volume of residues ending up in landfills. Integrated collection served as a structural link between the social system (community and producer behavior) and the technical system (waste service infrastructure), requiring service design, routing, and operational standards adapted to metropolitan conditions.

The processing stage, through facilities such as TPST and RDF, represented the material transformation dimension of the system, namely the conversion of waste into new resources or energy. However, this model emphasized that processing technology could not function as the primary solution, as its effectiveness was largely determined by the quality of upstream inputs, particularly waste composition and sorting levels. Remaining residues that could not be economically or technically processed still flowed to landfills, which within the system framework were positioned as the final component, not the center of the system.

The key uniqueness of this model lay in cross-sectoral interventions that operated horizontally across the upstream–downstream chain, including regulations, Extended Producer Responsibility (EPR), public education, economic incentives, and digital data systems. These interventions were not positioned as separate sectoral programs, but as systemic policy instruments operating simultaneously at every stage. Regulations established normative frameworks and obligations, EPR expanded the responsibilities of non-state actors, education supported behavioral change, economic incentives shaped actor decisions, and digital data systems strengthened monitoring, evaluation, and evidence-based decision-making.

Thus, this model emphasized that cross-sectoral integration in metropolitan waste management should be understood as systemic integration, not merely inter-agency coordination. Integration occurred not only at the organizational level, but also at the policy and service-chain level, where each instrument reinforced the others to form a coherent management system from upstream to downstream. This model represented a paradigm shift from a sectoral and reactive approach toward a systemic, preventive, and collaborative governance approach oriented toward long-term sustainability.

Figure 3 illustrated that waste management in Jakarta operated as an integrated system rather than a linear process. The model highlighted that upstream activities, such as waste reduction and sorting, directly influenced downstream efficiency. The figure also emphasized the role of cross-sectoral policy instruments such as regulation, extended producer

responsibility, and economic incentives operating across all stages of the system. The presence of feedback loops indicated that monitoring and evaluation mechanisms could influence upstream behavior, thereby reinforcing a circular and adaptive governance system.

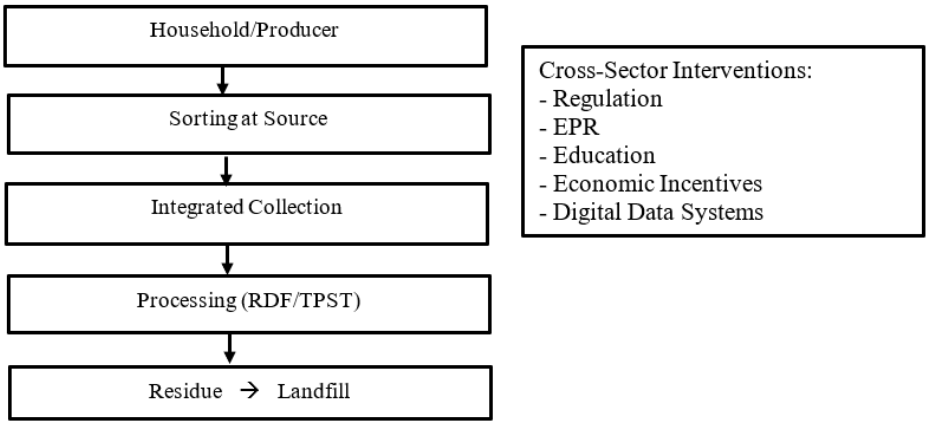

Figure 3. Upstream–downstream cross-sector integration model.

3.5.2. Integrated model for land waste management and marine waste prevention.

This model illustrated the flow of waste from land-based sources to aquatic ecosystems through the urban hydrological system. Waste generated from household activities, residential areas, economic activities, and public spaces flowed into the urban river network and drainage system. The drainage network and rivers served as the primary transport pathways, carrying waste from land areas to river estuaries, and subsequently into the ocean, contributing to coastal and marine pollution.

Along this flow, the government played a role through cross-sectoral policy and program interventions. These interventions included waste policies regulating reduction, collection, and processing; drainage infrastructure management to control waste flow; river normalization programs to reduce sedimentation and waste accumulation; public education to encourage behavioral change; and coastal surveillance to prevent and control marine pollution.

This model demonstrated that the flow of waste from land to sea was a series of interconnected processes, and therefore could not be addressed in isolation. Land-based waste management, river and drainage management, and coastal and marine protection formed an integrated system, requiring simultaneous interventions at each stage of the flow to effectively and sustainably reduce waste leakage into the sea.

Figure 4 demonstrated that marine debris was primarily the result of land-based waste leakage through interconnected urban systems, including drainage networks and river flows. The model emphasized that effective intervention must occur at multiple points along this pathway. Rather than treating marine waste as an isolated issue, the figure highlighted the need for integrated governance across land-based waste management, water infrastructure, and coastal protection. This reinforced the argument that preventing marine pollution required upstream intervention and cross-sectoral coordination.

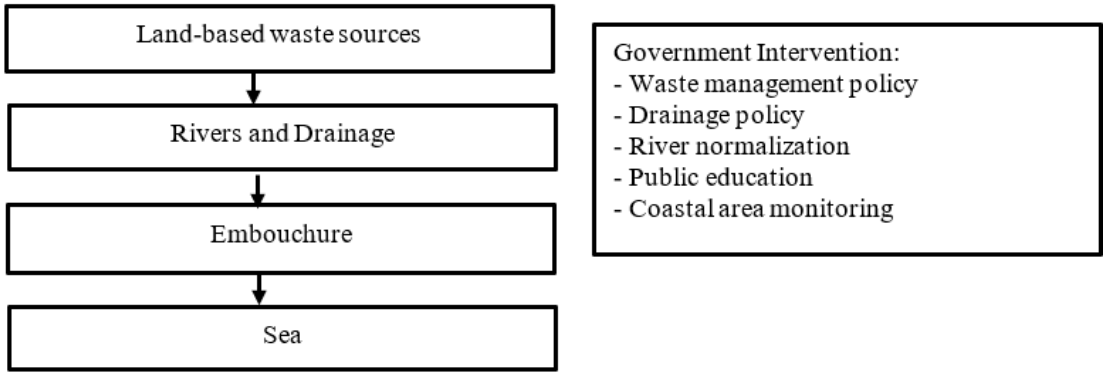

Figure 4. Integration model of land waste management and marine waste prevention.

4. Conclusions

Waste management in Jakarta can no longer be seen as a purely technical issue but rather as a governance challenge that requires stronger cross-sectoral integration, not only formal coordination between agencies. Local governments play a central role as regulators, coordinators, service providers, and supervisors throughout the entire waste management policy chain. However, the synthesis of findings indicates that policy approaches still tend to focus on downstream management rather than strengthening reduction at source. Challenges in institutional capacity, cross-agency coordination, and community participation remain major obstacles to upstream-to-downstream policy integration. Strengthening the role of local governments needs to be directed toward repositioning strategies for measurable reduction at source, optimizing producer responsibility instruments and economic instruments, and integrating land-based waste management with measures to prevent leakage into waterways. Cross-sectoral integration will only be effective if it is accompanied by clear role allocation, a data-driven monitoring system, and operational collaborative governance. Therefore, improving waste management in Jakarta is not only about expanding infrastructure but also about strengthening policy consistency, institutional capacity, and coordination among stakeholders, as well as ensuring synergy between actors within a sustainable metropolitan governance framework. The conceptual model developed in this article can serve as a theoretical and practical reference for formulating sustainable metropolitan waste management policies.

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Author Contribution

Rajanner Pangihutan Simarmata (first author) contributed to the study through research supervision, critical review and revision of the manuscript, and acquisition of funding and research resources. Ficky Adi Kurniawan (second author) was responsible for study conceptualization, methodological design, data collection, data analysis and interpretation, and

preparation of the original draft manuscript. Both authors reviewed, approved, and agreed to be accountable for all aspects of the final manuscript.

Competing Interest

The authors declare that they have no competing financial, personal, or professional interests that could have influenced, or be perceived to have influenced, the research presented in this article.

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