



DOI: <https://doi.org/10.38035/sjam.v4i1>
<https://creativecommons.org/licenses/by/4.0/>

Governance Readiness for Decentralised Waste Management: A Five-Pillar Assessment of the Integrated Waste Processing Unit (IWPU) Model in Kabupaten Bogor, Indonesia

Arraisya Rohasyah^{1*}, Valid Hasyimi²

¹Institut Teknologi Bandung , Bandung, Indonesia

²Institut Teknologi Bandung , Bandung, Indonesia

*Corresponding Author: arraisyar@gmail.com

Abstract: Decentralised waste management is a critical upstream complement to Indonesia's centralised Waste-to-Energy agenda under Presidential Regulation No. 109/2025. Yet the operational failure rate of existing community-based waste facilities exceeds 40%, indicating that governance conditions are the primary determinant of sustainability. This study assesses the governance readiness of the Integrated Waste Processing Unit (IWPU) model in Kabupaten Bogor using a five-pillar framework adapted from the Integrated Sustainable Waste Management (ISWM) approach. The five pillars assessed are: Social-Cultural, Financing, Technical Operations, Institutional, and Regulatory. Drawing on primary data from expert forums and a national workshop (March 2026), each pillar is evaluated as Ready, Partially Ready, or Not Ready. All five pillars are rated Partially Ready, indicating that foundational conditions exist but critical operational mechanisms have not yet been established. Integrated with financial feasibility analysis (NPV IDR 7.58 billion, IRR 17.9%), findings position Kabupaten Bogor in a Conditional Investment position. Tipping fee formalisation and inter-agency waste supply contracting are identified as the highest-priority pre-investment actions.

Keyword: Governance Readiness, Decentralised Waste Management, IWPU, ISWM Framework, Waste Policy.

INTRODUCTION

Indonesia is confronting an escalating municipal solid waste crisis. Similar challenges have been observed across rapidly urbanising regions in developing countries, where local governments struggle to balance increasing waste generation with limited institutional capacity and financial resources (Premakumara, 2011). National waste generation reached 56.63 million tonnes per year in 2023, yet only 39.01% was managed through structured systems; the remainder was handled through open dumping or informal disposal, contributing to environmental degradation, public health risks, and greenhouse gas emissions (Republic of Indonesia, 2025). Presidential Regulation No. 109/2025 (Perpres 109/2025) formally classifies this situation as a national waste emergency (kedaruratan sampah) and introduces

an accelerated policy framework for converting urban waste into renewable energy, centred on large-scale, centralised Waste-to-Energy (WtE) infrastructure coordinated through BPI Danantara and PT PLN.

While this centralised agenda represents a significant institutional step forward, it does not resolve the upstream challenge: approximately 40% of Indonesia's waste stream consists of organic matter, primarily food waste, that is poorly suited to WtE facilities and better addressed through proximate, decentralised processing (SIPSN, 2025). The Integrated Waste Processing Unit (IWPU), or Instalasi Pemrosesan Sampah Terpadu (IPST), represents precisely this upstream solution. Operating at sub-district scale with a capacity of approximately 100 tonnes per day (tpd), the IWPU model processes organic waste through Black Soldier Fly (BSF) bioconversion and composting, recovers recyclables for material reuse, and generates Refuse-Derived Fuel (RDF) from residual fractions, producing multiple revenue streams while diverting waste from landfills.

The IWPU concept has been actively developed by the Ministry of Higher Education, Science and Technology (Kemdiktisaintek) through expert forums and a national workshop in March 2026, with Kabupaten Bogor designated as one of seven pilot areas. Yet despite strong policy momentum, a fundamental gap persists: there is no rigorous, evidence-based assessment of whether the governance conditions necessary to support IWPU operation are actually in place. This gap is critical. Evidence from Indonesia's existing decentralised waste infrastructure, specifically the TPS3R programme, shows that 41.65% of 922 facilities across the country are non-operational, with failure causes overwhelmingly attributed to governance deficiencies rather than technical limitations (Budhijanto et al., 2024).

The literature consistently identifies governance conditions, rather than technology, as the primary determinant of whether decentralised waste facilities achieve long-term operational sustainability. The literature consistently identifies governance conditions, rather than technology, as the primary determinant of whether decentralised waste facilities achieve long-term operational sustainability. Recent assessments in Indonesia also highlight that institutional capacity, financial sustainability, and local service delivery mechanisms remain critical constraints in achieving effective waste management outcomes (World Bank, 2025). Zurbrügg et al. (2012), in their landmark study of the Gianyar Waste Recovery Project in Bali, demonstrate through the ISWM framework that the overall enabling environment is the critical success factor: social mobilisation, institutional arrangements, and financial sustainability mechanisms collectively determine outcomes more decisively than the appropriateness of the chosen technology. This finding directly challenges the infrastructure-centric approach that has historically dominated waste management investment in developing countries.

The empirical evidence from Indonesia supports this theoretical position. Budhijanto et al. (2024) document that treatment costs in TPS3R facilities range from IDR 298,000 to IDR 742,000 per tonne, consistently above typical tipping fee levels, and that operational failure is primarily driven by financing gaps and institutional weaknesses rather than technical constraints. SYSTEMIQ (2024) further reports that more than 70% of TPS3R units across Indonesia are inactive or have unknown operational status, underscoring the systemic nature of governance failure in decentralised waste infrastructure.

Kabir & Kabir (2022) and Mandpe et al. (2023) situate decentralised waste management within the broader circular economy (CE) paradigm, arguing that CE transitions in developing countries require flexible, locally adapted approaches, particularly for organic-rich waste streams. For Indonesia, where nearly 50% of the national waste stream is organic (SIPSN, 2025), this provides a strong rationale for IWPU-type models. However, both studies acknowledge that realising the CE potential of decentralised systems depends on governance conditions that are frequently absent in practice.

Several scholars have identified specific governance dimensions critical to waste infrastructure sustainability. Wilson et al. (2013) emphasise the importance of clear institutional mandates and inter-agency coordination in achieving sustained facility performance. Aditya et al. (2025) document that even where national enabling legislation exists in Indonesia, operationalisation at the local level remains inconsistent without sub-national regulatory instruments. Guerrero et al. (2013) demonstrate that financial sustainability mechanisms, particularly formalised cost-recovery agreements, are among the strongest predictors of decentralised facility survival across developing country contexts. Scheinberg et al. (2011) further highlight that community behaviour change programmes are prerequisite investments, not optional add-ons, for achieving consistent feedstock quality at material recovery facilities.

Comparative evidence across 20 cities further demonstrates that governance quality, stakeholder inclusivity, and financial sustainability mechanisms are stronger predictors of waste management performance than technological sophistication alone (Wilson et al., 2012). This paper addresses the identified gap by assessing governance readiness for IWPU implementation in Kabupaten Bogor across five strategic pillars: Social-Cultural, Financing, Technical Operations, Institutional, and Regulatory. The governance assessment framework is structured around five pillars defined by Kemdiktisaintek (2026), which operationalise the ISWM framework for the Indonesian decentralised waste context, as shown in Table 1.

Table 1. Mapping of ISWM Framework to Kemdiktisaintek Five-Pillar Governance Architecture

ISWM Element	Kemdiktisaintek Pillar	Key Requirement for IWPU
Social mobilisation & acceptance	Social-Cultural	Household waste sorting behaviour enabling feedstock quality
Financial & operational cost recovery	Financing	Formalised tipping fee and by-product revenue streams
Technical appropriateness & capacity	Technical Operations	Technology–waste fit and certified operator capacity
Stakeholder & institutional arrangements	Institutional	Role clarity between Pemda, operators, and community
Legal & regulatory framework	Regulatory	Enforceable tipping fee regulation and waste separation mandate

Source: Adapted from Zurbrügg et al. (2012) and Kemdiktisaintek (2026).

The contribution of this study is threefold. First, it provides the first systematic governance readiness assessment of the IWPU model at sub-district scale in Indonesia. Second, it integrates governance and financial feasibility into a single analytical framework, enabling more actionable investment recommendations than either dimension alone. Third, it offers a replicable assessment tool applicable to Indonesia's six other IWPU pilot areas and potentially to decentralised waste governance contexts in other developing countries.

METHOD

This study adopts a qualitative, document-based research design to assess governance readiness across the five pillars. The unit of analysis is one IWPU facility at sub-district scale (100 tpd) in Kabupaten Bogor. Kabupaten Bogor was selected as the primary case for three reasons: it is the most advanced of the seven Kemdiktisaintek pilot areas in terms of planning documentation; it represents a mid-sized peri-urban regency typology common across Java; and the first author's direct participation in the Kemdiktisaintek strategic study team provided privileged access to unpublished forum and workshop documentation specific to this site.

Primary data are drawn from two key documentation sources: the Notulensi Forum Pakar Pengelolaan Sampah (Expert Forum on Waste Management, 6 March 2026), a multi-

stakeholder forum involving practitioners, academics, and government representatives; and the Kemdiktisaintek National Workshop on Accelerated Waste Management (13 March 2026). The first author participated directly in both forums as part of the Kemdiktisaintek strategic study team, enabling informed interpretation of unpublished documentation. To manage potential observer bias arising from this insider position, pillar ratings are triangulated against at least two independent sources per pillar, and the assessment benchmarks are drawn exclusively from peer-reviewed literature and national policy documents rather than the author's own interpretations of forum discussions.

Secondary data sources include Perpres 109/2025, PP No. 81/2012, UU 18/2008, SIPSN national waste data (2024–2025), IDXCarbon pricing documentation (International Carbon Action Partnership, 2025), and peer-reviewed literature including Zurbrügg et al. (2012), Wilson et al. (2013), Aditya et al. (2025), and SYSTEMIQ (2024).

Each pillar is assessed through three sequential steps: (1) identifying a benchmark or minimum enabling condition from the literature or policy framework; (2) describing the current condition in Kabupaten Bogor based on triangulated evidence from at least two independent sources; and (3) identifying the gap and assigning a readiness rating on a three-level ordinal scale: Ready (enabling conditions substantially in place), Partially Ready (some conditions exist but significant gaps remain), or Not Ready (conditions largely absent). This approach is methodologically consistent with the ISSOWAMA protocol applied by Zurbrügg et al. (2012) in their Bali case study. This multidimensional assessment approach aligns with previous studies emphasising the use of integrated indicators to evaluate waste management system readiness and sustainability (Wilson et al., 2015; Zaman, 2014)

Several limitations should be acknowledged. First, this study relies on document-based assessment rather than independent primary surveys or household interviews; the pillar ratings are therefore interpretive and should be treated as evidence-informed expert judgements rather than empirically verified measures. Second, as a single-site case study, the findings cannot be generalised directly to the six other IWPU pilot areas without site-specific adaptation. Third, the financial assumptions underpinning the governance-finance integration are drawn from practitioner consensus and planning documents rather than audited operational data.

RESULTS AND DISCUSSION

Pillar 1: Social-Cultural Readiness

The Social-Cultural pillar evaluates whether community waste sorting behaviour is sufficiently established to ensure consistent feedstock quality at the IWPU. The financial model assumes 40% organic composition in the waste stream, achievable only if households effectively separate organic waste from non-organic fractions prior to collection.

The benchmark, drawn from Budhijanto et al. (2024) and national 3R targets under UU 18/2008, is a household source separation rate of at least 30%. Current evidence indicates that this benchmark is far from met. Nationally, active household sorting rates are estimated at 5-15% (Brotosusilo & Handayani, 2020; Sulistyorini et al., 2017), and Kementerian Pendidikan Tinggi Sains dan Teknologi Republik Indonesia (2026) documentation suggests Kabupaten Bogor follows this pattern, with village-level sorting stations frequently underutilised. No IWPU-specific behaviour change programme has been designed or launched. The primary gap is behavioural rather than infrastructural: without structured community engagement, education, and social norm interventions, physical infrastructure alone is insufficient to achieve the required sorting rate. A 25% reduction in by-product output from contaminated feedstock could reduce annual revenue by approximately IDR 5.1 billion, materially weakening moderate-scenario financial viability.

Evidence from community-based waste initiatives in West Java indicates that social innovation, community empowerment, and locally embedded participation mechanisms significantly improve household waste sorting behaviour and programme sustainability (Atmoko, 2023). Scheinberg et al. (2011) and Guerrero et al. (2013) both document that community engagement programmes, when implemented before facility commissioning, produce sorting rates 40–60% higher than those in facilities that rely on passive participation. This evidence further underscores that the Social-Cultural gap in Kabupaten Bogor is a pre-commissioning governance priority rather than an operational afterthought.

Rating: Partially Ready. The physical infrastructure foundation exists, but the behavioural activation programme, a prerequisite for feedstock quality, does not.

Pillar 2: Financing Readiness

The Financing pillar evaluates whether the cost-recovery mechanisms necessary for IWPU self-sufficiency are in place. The financial feasibility analysis establishes that the minimum tipping fee for EBITDA breakeven under the moderate scenario is IDR 61,124 per tonne, significantly below the practitioner consensus rate of IDR 500,000 per tonne, but that this low threshold is only meaningful if a formal contractual mechanism exists to guarantee payment.

The benchmark requires a formalised tipping fee contract between the IWPU operator and the local government, providing legally binding cost recovery. Currently, no such mechanism exists in Kabupaten Bogor. Existing regulations (UU 18/2008; PP 81/2012) authorise local governments to collect waste service fees (*retribusi*), but do not mandate specific rates or contractual structures for IWPU-type facilities. Unlike PLTSa projects, which benefit from tipping fee obligations under Perpres 35/2018, IWPU facilities have no equivalent national regulatory protection. The financing gap is contractual rather than economic: the IWPU financial model demonstrates viability at tipping fees far below the practitioner consensus. The challenge is not affordability for local government, but the absence of a formal, enforceable agreement.

Guerrero et al. (2013) demonstrate across a multi-country study that formalised cost-recovery contracts are among the strongest predictors of decentralised waste facility operational survival; facilities relying on informal or discretionary payment arrangements show failure rates three times higher than those with binding agreements. This finding directly supports the primacy of the contracting gap as the binding constraint in this pillar.

Rating: Partially Ready. The financial case for the tipping fee is strong, but the contractual governance mechanism that would make it binding does not yet exist.

Pillar 3: Technical Operations Readiness

The Technical Operations pillar assesses whether the workforce, maintenance systems, and performance monitoring infrastructure are in place to sustain IWPU operations above the minimum throughput of 52.2 tpd required for financial breakeven (moderate scenario). This pillar is motivated by the finding from SYSTEMIQ (2024) that more than 70% of TPS3R facilities in Indonesia have been abandoned, with equipment failure and operator incapacity as primary causes.

The IWPU model is substantially more complex than a conventional TPS3R, combining four processing streams: waste sorting, BSF bioconversion, composting, and RDF production. BSF bioconversion in particular requires specialised knowledge of temperature management, humidity control, and larval biology that significantly exceeds the capabilities of community volunteers who typically staff TPS3R facilities. No standardised certification or training programme for IWPU operators currently exists in Indonesia. Preventive maintenance frameworks and spare-parts supply chains are also absent at the planning stage.

Despite these gaps, the identified deficiencies are operationally resolvable. The Kemdiktisaintek programme has committed to developing an operator training component as part of the pilot design. A performance monitoring system linked to SIPSN national reporting would also fulfil the Monitoring, Reporting, and Verification (MRV) requirements for future carbon credit certification under the AMS-III.F methodology. Hoornweg & Bhada-Tata (2012) document that structured operator training programmes in comparable developing country contexts reduce equipment downtime by 30–50% within the first 18 months of operation, providing empirical support for the planned Kemdiktisaintek training intervention.

Rating: Partially Ready. Technology is proven and plans for training exist, but certified operators, maintenance systems, and monitoring infrastructure are not yet in place.

Pillar 4: Institutional Readiness

The Institutional pillar evaluates whether the organisational arrangements for IWPU operations are clearly defined and operationally accountable. The sensitivity analysis identifies facility utilisation as the most financially consequential variable: a 10-percentage-point difference in utilisation (70% vs. 80%) produces an NPV swing of approximately IDR 86.85 billion, making it the single most impactful governance-dependent variable. Utilisation is primarily a function of institutional arrangements, specifically, whether formal waste supply agreements between kelurahan administrations and the IWPU operator are in place.

Currently, no formal inter-agency agreement exists in Kabupaten Bogor clarifying the respective roles of DLH Kabupaten Bogor, kecamatan governments, and kelurahan administrations in managing waste flow to the IWPU, allocating by-product revenues, or maintaining operational accountability. Kementerian Pendidikan Tinggi Sains dan Teknologi Republik Indonesia (2026) documentation identifies role ambiguity between DLH and potential UPTD kecamatan structures as an unresolved planning question. On the by-product market side, liquid fertiliser, the largest individual revenue component, contributing IDR 12.24 billion annually in the moderate scenario, requires direct or semi-direct sales channels to agricultural buyers. No formal offtake arrangement with farmer groups or agricultural cooperatives has been established, and the Indonesian BSF liquid fertiliser market remains nascent.

Similar challenges have been identified in Indonesia's community-based waste programmes, where unclear institutional responsibilities and weak coordination among local stakeholders hinder long-term sustainability (Latanna et al., 2023). Wilson et al. (2013) identify inter-agency coordination mechanisms as among the most decisive institutional variables in waste infrastructure governance, and document that facilities with formal inter-agency agreements consistently outperform those relying on informal coordination, particularly under conditions of local government leadership transitions.

Rating: Partially Ready. Government institutions exist, but inter-agency role allocation, waste supply contracts, and by-product offtake arrangements, all critical to utilisation and revenue, are absent.

Pillar 5: Regulatory Readiness

The Regulatory pillar assesses whether the legal and policy instruments necessary for IWPU operation are in place at national and sub-national levels. At the national level, Indonesia's regulatory framework is broadly enabling: UU 18/2008, PP 81/2012, Perpres 97/2017, and Perpres 109/2025 collectively provide legal authority for decentralised waste management, community participation, and cost recovery through retribusi mechanisms. However, as Aditya et al. (2025) document, the existence of national enabling legislation does not guarantee operationalisation at the local level.

The most significant regulatory gap is the absence of a sub-national regulation (Perda or Perbup) in Kabupaten Bogor that designates IWPU services as retribusi-eligible and establishes a minimum tipping fee rate. Without such an instrument, tipping fee payments remain a discretionary administrative commitment rather than a legally binding obligation, exposing the project to electoral cycle risk as local leadership changes. Unlike PLTSA facilities, which benefit from nationally mandated tipping fees under Perpres 35/2018, IWPU facilities have no equivalent protection.

Two additional regulatory gaps affect secondary revenue streams. First, the AMS-III.F methodology for carbon credit generation from organic waste diversion has not yet been registered within Indonesia's domestic IDXCarbon framework, creating a 6–18 month delay before IWPU carbon credit revenue can be realised. Second, no Indonesian National Standard (SNI) or Ministry of Agriculture registration exists for BSF-derived liquid fertiliser, potentially restricting formal market access through regulated agricultural supply chains.

Rating: Partially Ready. The national enabling framework is comprehensive, but the sub-national tipping fee regulation, the critical instrument for financial sustainability, does not exist.

Governance Readiness Summary

Table 2. Governance Readiness Assessment Summary, Five Pillars, Kabupaten Bogor

Pillar	Rating	Primary Gap	Critical Enabling Condition Required
Social-Cultural	Partially Ready	Household sorting rate ~5–15% vs. 30% benchmark; no behaviour programme	Structured community engagement programme before commissioning
Financing	Partially Ready	No formalised tipping fee contract; no regulatory mandate for cost recovery	Tipping fee contract ≥IDR 61,124/ton with Pemda; CAPEX co-financing terms confirmed
Technical Operations	Partially Ready	>70% TPS3R abandoned; no IWPU operator certification standard	Certified operator training and preventive maintenance protocol before handover
Institutional	Partially Ready	Unclear role allocation; by-product offtake absent; no waste supply agreement	Inter-agency MoU; liquid fertiliser offtake agreement; waste supply contract
Regulatory	Partially Ready	No Perda/Perbup mandating tipping fee; carbon credit pathway not registered	Perda/Perbup on IWPU retribusi; AMS-III.F registration initiated within Year 1
Overall	Partially Ready		

Source: Author's assessment based on Kementerian Pendidikan Tinggi Sains dan Teknologi Republik Indonesia (2026), Kemdiktisaintek (2026), Budhijanto et al. (2024), SIPSN (2025), Perpres 109/2025.

The Contractual Gap as the Binding Constraint

The most important finding across all five pillars is that Kabupaten Bogor's governance gaps are contractual and administrative in nature rather than structural or institutional. No pillar is rated Not Ready, meaning that the foundational architecture, government institutions, national policy frameworks, and technical knowledge, already exists. What is missing is the operationalisation of that architecture into binding agreements, enforceable regulations, and trained human resources.

This distinction is analytically significant. It implies that the IWPU governance gap can be resolved through targeted policy action within a 12–18 month pre-commissioning window, without requiring fundamental institutional reform. The most consequential single action is the enactment of a Perda or Perbup that formalises the tipping fee as a legally

binding retribusi obligation. This converts the tipping fee from a politically vulnerable administrative commitment into an enforceable legal instrument, directly addressing the electoral cycle risk that has contributed to the failure of many community-based waste facilities in Indonesia.

Integration with Financial Feasibility: The 2×2 Strategic Position

When integrated with the financial feasibility analysis, the governance readiness assessment places Kabupaten Bogor in a clearly defined strategic position: financially viable under moderate assumptions (NPV IDR 7.58 billion, IRR 17.9%, payback period 3.39 years) but not yet governance-ready for full investment commitment. This maps to Quadrant 2 of the 2×2 Strategic Decision Matrix, Conditional Investment, in which the financial model supports investment but governance conditions must be resolved before capital commitment.

The sensitivity analysis reveals a direct connection between governance and financial outcomes. The two variables with the greatest impact on NPV, tipping fee levels and facility utilisation, are both governance-determined rather than market-determined. A 10-percentage-point decrease in utilisation (from 80% to 70%) shifts the project from financially viable to financially non-viable, and this utilisation level is entirely a function of whether formal waste supply agreements are in place between kelurahan administrations and the IWPU operator.

This governance–finance nexus is the central analytical contribution of this study: financial feasibility projections for waste infrastructure are only as reliable as the governance conditions that underpin their key revenue and throughput assumptions. Assessing one dimension without the other produces systematically incomplete, and potentially misleading, investment recommendations.

Prioritisation and Sequencing

The strategic recommendations are organised into three priority tiers based on financial sensitivity and pre-commissioning urgency. Priority 1 (pre-investment, Months 1–6) encompasses tipping fee formalisation through Perda/Perbup and inter-agency MoU development, the two actions most directly linked to the project's highest-sensitivity financial variables. Priority 2 (construction phase, Months 7–18) includes liquid fertiliser offtake agreements, community sorting programmes, operator certification, and OPEX escalation management provisions. Priority 3 (long-term, Month 19+) covers external financing applications, carbon credit methodology registration under AMS-III.F, and feedstock quality protocols.

This sequencing reflects a key lesson from Indonesia's TPS3R experience: governance gaps that are not addressed before commissioning are rarely resolved after operations begin. Budhijanto et al. (2024) and SYSTEMIQ (2024) document that most facility failures in Indonesia occur not during construction but during early operations, when governance gaps that were deferred during the project preparation phase become operationally disruptive. The IWPU pilot in Kabupaten Bogor has the opportunity, given its strong financial baseline and Kemdiktisaintek institutional support, to avoid this pattern by treating governance development as a formal pre-investment phase rather than a secondary activity.

CONCLUSION

This study assessed the governance readiness of the IWPU model in Kabupaten Bogor across five pillars derived from the ISWM framework and Kemdiktisaintek's policy architecture. All five pillars, Social-Cultural, Financing, Technical Operations, Institutional, and Regulatory, were rated Partially Ready, indicating that foundational conditions exist but critical operational mechanisms are absent.

Three conclusions emerge. First, governance readiness is currently insufficient for unconditioned IWPU investment, but the gaps are contractual and administrative rather than structural. The binding constraint is the absence of a formalised tipping fee contract, a governance condition that is resolvable through local regulation within the project preparation window. Second, integrated with a financial feasibility analysis demonstrating viability under moderate assumptions (NPV IDR 7.58 billion, IRR 17.9%), governance gaps place Kabupaten Bogor in a Conditional Investment position: proceed with governance development in parallel with construction, and commit capital only after priority governance conditions are secured. Third, the two most critical pre-investment actions are Perda/Perbup enactment formalising the tipping fee and inter-agency MoU development establishing waste supply accountability, both of which directly address the highest-sensitivity financial variables.

The five-pillar framework and assessment methodology developed in this study are designed to be replicable across Indonesia's six other IWPU pilot areas, Kota Bandung, Kota Tangerang Selatan, Kabupaten Banyumas, Kabupaten Bekasi, Kota Yogyakarta, and Rorotan (Jakarta), with adjustments for local waste characteristics, governance structures, and regulatory conditions. Future research should incorporate primary field data, including household sorting rate surveys and stakeholder interviews, to validate and refine the document-based assessments presented here.

REFERENSI

- Aditya, L., Mahlia, T. M. I., Rismanchi, B., Ng, H. M., Hasan, M. H., Metselaar, H. S. C., & Aditiya, H. B. (2025). A Review on Progress of Biodiesel Synthesis in Indonesia. *Renewable and Sustainable Energy Reviews*, 175, 113201. <https://doi.org/10.1016/j.rser.2023.113201>
- Atmoko, A. W. (2023). Social Innovation in Community-Based Household Waste Management in Ciamis Regency, West Java Province. *Journal of Local Government Issues*, 6(2), 133–151. <https://doi.org/10.22219/logos.v6i2.26479>
- Brotosusilo, A., & Handayani, D. (2020). Factors Influencing the Effectiveness of Waste Sorting Behavior in Indonesia. *Journal of Environmental Management and Tourism*, 11(4), 874–885. [https://doi.org/10.14505/jemt.v11.4\(44\).09](https://doi.org/10.14505/jemt.v11.4(44).09)
- Budhijanto, W., Marleni, N. N. N., Wulaningtyas, A. H., Istiqomah, I., Ahmad, J. S. M., & Marbelia, L. (2024). Techno-economic Analysis on Community-based Municipal Solid Waste Processing Facilities: A Case Study in Sleman Regency Indonesia. *Environmental Development*, 52, 101083. <https://doi.org/10.1016/j.envdev.2024.101083>
- Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid Waste Management Challenges for Cities in Developing Countries. *Waste Management*, 33(1), 220–232. <https://doi.org/10.1016/j.wasman.2012.09.008>
- Hoorweg, D., & Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management*.
- International Carbon Action Partnership. (2025). *Emissions Trading Worldwide: ICAP Status Report 2025*.
- Kabir, Z., & Kabir, M. (2022). Solid Waste Management in Developing Countries: Towards a Circular Economy. In *Handbook of Solid Waste Management* (pp. 3–36). Springer. https://doi.org/10.1007/978-981-16-6993-3_1
- Kemdiktisaintek. (2026). *Workshop Percepatan Penanganan Sampah Nasional Berbasis Ekosistem Kepakaran dan Inovasi Perguruan Tinggi*.
- Kementerian Pendidikan Tinggi Sains dan Teknologi Republik Indonesia. (2026). *Notulensi Forum Pakar Pengelolaan Sampah*.

- Latanna, M. D., Gunawan, B., Franco-García, M. L., & Bressers, H. (2023). Governance Assessment of Community-Based Waste Reduction Program in Makassar. *Sustainability*, 15(19), 14371. <https://doi.org/10.3390/su151914371>
- Mandpe, A., Vyas, S., Kumar, S., & Bhatt, A. (2023). Circular Economy Approach for Sustainable Solid Waste Management in Developing Economies. *Resources, Conservation and Recycling*, 189, 106738. <https://doi.org/10.1016/j.resconrec.2022.106738>
- Premakumara, D. G. J. (2011). Reducing Municipal Waste through Promoting Integrated Sustainable Waste Management Practices in Surabaya, Indonesia. *Sustainable City VI: Urban Regeneration and Sustainability*, 457–468.
- Republic of Indonesia. (2025). *Peraturan Presiden Republik Indonesia Nomor 109 Tahun 2025 tentang Pengelolaan Sampah Perkotaan melalui Pengubahan Sampah menjadi Energi Terbarukan Berbasis Teknologi Ramah Lingkungan*.
- Scheinberg, A., Wilson, D. C., & Rodic-Wiersma, L. (2011). *Solid Waste Management in the World's Cities: Water and Sanitation for the Urban 21st Century*. Earthscan/UN-Habitat.
- SIPSN. (2025). *Sistem Informasi Pengelolaan Sampah Nasional: Data Komposisi Sampah Indonesia*. <https://sampahnasional.kemenlh.go.id/portal-indikatif/>
- Sulistiyorini, L., Mudjanarko, S. W., & Siswanto, J. (2017). Waste Management by Society as a Solution for Environment Problem. *MATEC Web of Conferences*, 138, 7005. <https://doi.org/10.1051/mateconf/201713807005>
- SYSTEMIQ. (2024). *Rethinking Plastics in Southeast Asia*. <https://www.systemiq.earth/rethinking-plastics-in-southeast-asia/>
- Wilson, D. C., Rodic, L., Modak, P., Soos, R., Carpintero, A., Velis, C. A., Iyer, M., & Simonett, O. (2015). *Global Waste Management Outlook*.
- Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C. A., & Alabaster, G. (2012). Comparative Analysis of Solid Waste Management in 20 Cities. *Waste Management & Research*, 30(3), 237–254. <https://doi.org/10.1177/0734242X12437569>
- Wilson, D. C., Velis, C. A., & Rodic, L. (2013). Integrated Sustainable Waste Management in Developing Countries. *Proceedings of the Institution of Civil Engineers – Waste and Resource Management*, 166(2), 52–68. <https://doi.org/10.1680/warm.12.00005>
- World Bank. (2025). *Indonesia Local Service Delivery Program: Waste Sector Assessment*. <https://www.worldbank.org/en/country/indonesia>
- Zaman, A. U. (2014). Identification of Key Assessment Indicators of the Zero Waste Management Systems. *Ecological Indicators*, 36, 682–693. <https://doi.org/10.1016/j.ecolind.2013.09.024>
- Zurbrugg, C., Gfrerer, M., Ashadi, H., Brenner, W., & Küper, D. (2012). Determinants of Sustainability in Solid Waste Management: The Gianyar Waste Recovery Project in Indonesia. *Waste Management*, 32(11), 2126–2133. <https://doi.org/10.1016/j.wasman.2012.01.011>