Financial Analysis of Solid Waste Management Business Models

Case Studies in Indonesia and Brazil

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CLIMATE POLICY INITIATIVE

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AUTHORS

Berliana Yusuf, Ravi Bimo, Harry Gembira, Fatihatul Nurfitriani, and Ira Purnomo

CONTACT

Berliana Yusuf
Berliana.yusuf@cpiglobal.org

ABOUT CLIMATE POLICY INITIATIVE

CPI is an analysis and advisory organization with deep expertise in finance and policy. Our mission is to help governments, businesses, and financial institutions drive economic growth while addressing climate change. CPI has seven offices around the world in Brazil, India, Indonesia, South Africa, the United Kingdom, and the United States.

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MEDIA CONTACT

Rindo Saio
Rindo.saio@cpiglobal.org

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LIST OF ABBREVIATIONS

BSF	Black Soldier Fly
EPR	Extended producer responsibility
LCOW	Levelized cost of waste management
M&E	Monitoring & Evaluation
MoEF	Ministry of Environment and Forestry (split into two ministries since October 2024: Ministry of Environment and Ministry of Forestry)
MPWH	Ministry of Public Works and Housing (split into two ministries since October 2024: Ministry of Public Works and Ministry of Housing and Settlement Areas)
RDF	Refuse-derived fuel
SWM	Solid waste management
YPBB	Yaksa Pelestari Bumi Berkelanjutan

EXECUTIVE SUMMARY

Human-driven methane emissions are responsible for nearly 45% of current net global warming (IPCC, 2023), with waste (solid and wastewater) contributing around 20% (UNEP and CCAC, 2021). **Despite this, financial flows to organic waste management are alarmingly low and concentrated in large-scale projects.** Around 94% (USD 4.08 billion) of methane abatement finance in the waste sector went to waste-to-energy incinerators in 2021/22, and only 1% (USD 20 million) to organic waste management (CPI, 2023).

Moreover, waste management finance has not generally considered the inclusion of local communities and informal sectors, particularly in emerging markets and developing economies, where such groups are often affected by waste management projects and also partake in implementing climate action. To deliver fast action on methane abatement in the waste sector, a deeper assessment of financial flows, viability, and opportunities involving all organic waste management stakeholders is needed.

Under the coordination of the Global Alliance for Incinerator Alternatives (GAIA), CPI has conducted **financial analysis of various waste management business models** based on data provided by the NGOs *Yaksa Pelestari Bumi Berkelanjutan* (YPBB) in Bandung, Indonesia, and Instituto Pólis in Brazil. The analysis included:

- Seven case studies from Indonesia, covering three business models implemented by the government, private companies, and communities.
- Nine cases from Brazil, covering four business models implemented by: the government, private companies, waste picker cooperatives, and households through home composting. One additional case from Brazil was also examined separately from the others, given that it was the only public-private partnership examined.

KEY FINDINGS

- **Public (municipal) budget allocations for waste management in both Indonesia and Brazil are low and mainly go to large-scale projects**. Brazil has a higher allocation (ranging from 1.9% to 5.1% of each municipal budget across the country) than Indonesia (ranging from 0.3% to 2.4% across the sampled five cities).
- **Among the sampled waste management operator types, those with decentralized models show potential for greater cost efficiency.** These were community groups in Indonesia, and waste picker cooperatives and home composting in Brazil.
    - **Community-based and informal operators were competitive in terms of levelized cost of waste management (LCOW),**[1] despite recording the lowest operating margins (-49% to -628% for community groups in Indonesia and 7% to 16% for waste picker cooperatives in Brazil). Community groups in Indonesia had an LCOW of USD 28-63/tonne, compared to USD 11-92/tonne for private operators and USD 49-59/tonne for

1 The LCOW is the total investment and operational cost over the lifetime of the facilities (assumed as 20 years) divided by the total volume of waste being treated over the same period.

government operators. In Brazil, home composting had an LCOW of USD 1.69-19.12/tonne, waste picker cooperatives USD 17.63-20.90/tonne, private operators USD 74.65-324.10/tonne, and government-operated facilities USD 22.96-46.36/tonne.

   - **Decentralized models achieve cost efficiencies due to several advantages in terms of capital expenditure and operational expenditure**. Capital expenditure on fixed assets (e.g., land acquisition) contributes the most to total asset value (accounting for 89% in relevant Indonesian cases and 58% in Brazil), presenting a major potential barrier to entry for industrial players, but less so for decentralized models such as home composting.
   - **Operational expenditure is the main cost driver for all groups across both countries, except for home composting in Brazil**. Labor is the largest operational expense (ranging from 74% to 98% in Indonesia and 48% to 90% in Brazil), demonstrating how the waste management sector is labor-intensive and can create jobs.

- **Co-benefits are particularly present in government- and community-operated business models sampled**. Co-benefits include job creation, provision of food from farming using waste management byproducts, and improved air and water quality from reduced methane and CO_2 emissions from waste processing and transportation. The co-benefits across models are presented in the Appendix (Tables A3 and A4).
- **Community groups have the most complex capital structures**, comprising finance from private entities (49%) and the government (48%), as well as grants from corporate social responsibility and philanthropic sources (3%). However, their operational funding is entirely derived from their operational revenues. This can create financial strain, especially given that their small waste processing volumes and high labor dependency raise operating costs per tonne. **Reliance on shorter-lived assets further increases community groups' need for recurrent capital inflows**, **placing pressure on their funding mechanisms.**

Based on the above findings, the following action items are recommended to help scale up organic solid waste management in Indonesia and Brazil:

1. **Design a holistic approach to waste management.** Waste management should not be considered in isolation; it should be linked with other important sectors such as health, environment, and climate change mitigation.
2. **Involve all stakeholders in waste management, including communities and informal workers.** As neither the public nor the private sector can fully cover all waste management needs alone, the government should lead, coordinate, and involve all stakeholders, including informal workers and community groups that participate in waste management activities.
3. **Create measurable and transparent indicators to measure and monitor the implementation of waste management interventions.** Both public and private projects should have a monitoring and evaluation system with measurable indicators, including to calculate budget savings resulting from upstream organic waste management measures.
4. **Create legal status/certainty for informal stakeholders in the waste management sector.** It is important to create a legal contract between all waste management operators, including informal service providers, with the government or other entities receiving the service, to ensure cashflow and thus equal access to project financing from banks or other private financing institutions.

The above recommendations, based on lessons from Indonesia and Brazil, can inform waste management strategies that create benefits for communities. **However, we note that this initial study had a limited sample size and some data gaps relating to operational costs, community assets, and revenues**. Larger samples with improved data granularity should be used in future studies to more accurately represent the target waste treatment business models and yield more generalizable findings.

CONTENTS

1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

The concentration of methane (CH_4) is increasing rapidly in the atmosphere, and is currently 2.5 times higher than in the pre-industrial era (IEA, 2023). This greenhouse gas has a 20-year warming power of over 80 times higher than that of CO_2 (Forster et al., 2021). Human-driven methane emissions are responsible for nearly 45% of current net warming (IPCC, 2023), with 95% of these emissions derived from three sectors: 1) agriculture, forestry, and other land use (AFOLU; 40%); 2) fossil fuels (encompassing coal, oil, and natural gas; 35%); and 3) waste (20%), including both solid waste and wastewater (UNEP and CCAC, 2021).

As methane abatement finance has one of the highest ratios of global warming benefit per dollar invested (CPI, 2022), more financing for this area can help to keep the world within a 1.5°C warming pathway. Studies show that source-separated collection and treatment of waste can reduce methane emissions from landfills by 62% (GAIA, 2022). Some existing organic waste treatment methods not only abate methane but also provide value-added products such as black soldier fly (BSF) maggots, which are used as feed for poultry and fish farms. Nonetheless, finance for organic waste management projects, such as vermicomposting, is still quite low and focused on large-scale projects.

CPI research shows that 94% (USD 4.08 billion) of methane abatement finance in the waste sector went to waste-to-energy incinerators on average annually over 2021/22, and only 1% (USD 20 million) to organic waste management (CPI, 2023). Most waste-to-energy financing came from the private sector, with projects often made attractive to investors using significant public subsidies (CPI, 2022). It is also important to note that thermal waste-to-energy technologies (i.e. waste incineration) emit 1.43 tonnes of CO_2 per tonne of plastic burned, even after energy recovery (GAIA, 2022).

Black soldier fly (BSF) maggots

Community group composting example

Increasing finance for organic waste treatment could help to realize methane abatement potential. Moreover, investments in organic waste management should further consider the inclusion of local communities and informal sectors, particularly in emerging markets and developing economies, where such groups are often affected by waste management projects and also participate in the implementation of climate action. A deeper assessment of financial flows, financial viability, and financing opportunities for all stakeholders in waste management is needed to deliver fast action on methane abatement in the waste sector.

CPI has worked with *Yaksa Pelestari Bumi Berkelanjutan* (YPBB) in Indonesia[2] and Instituto Pólis in Brazil,[3] under the coordination of GAIA, to better understand these aspects of organic waste treatment business models in Bandung, Indonesia, and several cities in Brazil. This report also explores strategies to scale up existing business models to enable more equitable finance, with recommendations made based on the financial analysis of these strategies.

1.2 CASE STUDY SELECTION

This report presents case studies from Bandung and Brazil, with data collected by YPBB and Instituto Pólis, respectively, and shared with CPI for financial analysis:

- YPBB provided seven samples from Bandung, covering businesses operated by three stakeholder types: government, private companies, and community groups.
- Instituto Pólis sampled ten businesses operated by four stakeholder types (government, private sector, waste picker cooperatives, and home composting) from eight municipalities in Brazil: Araraquara, Entre Rios, Florianópolis, Lages, São Paulo, Santa Cecília do Sul, Sertãozinho, and Rio de Janeiro.

This study focuses on organic solid waste management. However, some of the sampled business models (and a conventional business model considered for comparison)[4] manage both organic and inorganic waste. We refer to "solid waste management" and "organic waste management" to differentiate between the two, where relevant.

CPI has grouped the sampled entities based on their characteristics. For example, because all samples from Bandung use the same waste treatment technologies (composting and BSF), these samples were grouped based on their operator type.

1.3 DATA ANALYSIS

CPI conducted a financial analysis of the selected cases using performance indicators, including operational revenue margin, payback period, and the levelized cost of waste management (LCOW).

2 YPBB is a non-profit organization based in Bandung, West Java, Indonesia, that promotes a lifestyle in harmony with nature to achieve a high and sustainable quality of life.
3 Instituto Pólis is a Brazil-based NGO that takes national and international action to build fair, sustainable, and democratic cities through research, advice, and training to support public policies and the advancement of local development.
4 The conventional business model considered for comparison is Tempat Pengolahan Sampah Terpadu Edukasi, a facility that manages waste through various treatment processes while also serving as a public education center to raise awareness about sustainable waste management practices.

LCOW is the total investment and operational cost over the lifetime of the facilities (assumed as 20 years) divided by the total volume of waste being treated over the same period. The formula is similar to that of the levelized cost of electricity (LCOE) but without a degradation ratio. LCOW is used to compare different business models with the assumption that there is no degradation in the volume of waste treated over the year using similar technology.

All business model samples provided to CPI in Bandung use similar technology—composting and BSF—meaning that there may be little variation in degradation rate. While most of the Brazil cases also treat waste using composting, there is not significant variance in the volume being treated over the year. However, if the opposite applies, the formula should be adjusted using a discount factor (see further details about data analysis in Section 2). In addition to conducting the financial performance analysis, CPI also mapped public finance flows (from government budgets) in the two countries.

1.4 DATA GAPS

Not all the required data was available for financial analysis. This includes data on prices for assets used by community groups, certain revenues such as from the sales of BSF maggots and vegetables, and some operational costs. To approximate the value of equipment that community groups received via grants, CPI used market price data from online marketplaces in the same areas. For sales of BSF maggots and vegetables, an estimation of the average revenue was obtained via interviews. In some cases, however, communities used products from waste management activities for free, without recording their distribution. This could undermine the validity of data on the revenue generation of the business models.

For future studies, these gaps could be reduced by improving data granularity, especially in terms of bookkeeping/transaction records, and by increasing the sample size to more accurately represent the target waste treatment business models, thereby producing more generalizable findings.

2. CASE STUDIES

2.1 BANDUNG

2.1.1 PUBLIC FINANCE ANALYSIS

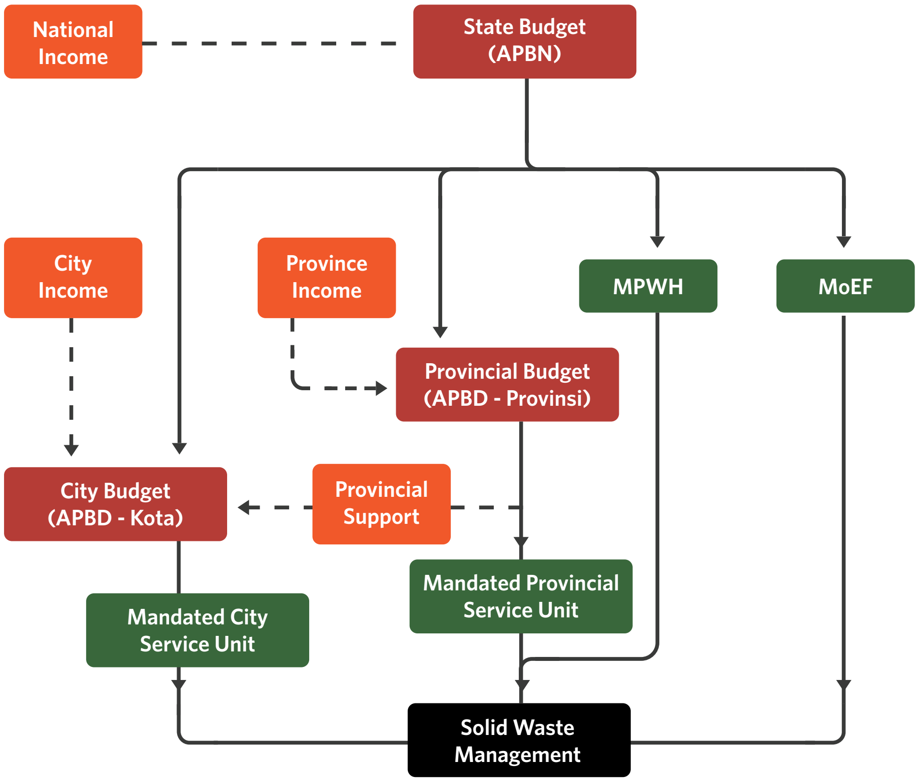
PUBLIC FINANCING GOVERNANCE FOR SOLID WASTE MANAGEMENT IN INDONESIA

In Indonesia, responsibilities for solid waste management (SWM) are divided between the national and regional (provincial and municipal/district) levels. The Ministry of Public Works and Housing (MPWH) and the Ministry of Environment and Forestry (MoEF) oversee programs and activities at the national level, while subnational responsibilities are delineated between provincial and city governments. For instance, landfill management typically falls to provincial governments, while municipal Integrated waste management sites are managed by city governments.

Indonesia's "money follows program" approach allocates funds based on programmatic needs. The following figure provides a visual summary of funding flows for SWM in Indonesia.

Small-scale organic waste management in Bandung, Indonesia

Figure 1: Public funding flows for SWM in Indonesia[5]



Under the new President, the MoEF has been split into the Ministry of Environment (MoE) and the Ministry of Forestry since October 2024. The MPWH has also been split into the Ministry of Public Works and Ministry of Housing and Settlement Areas. Until new regulations on waste management replace existing ones, the above funding flows are still relevant, with the waste management responsibility now assigned to the MoE.

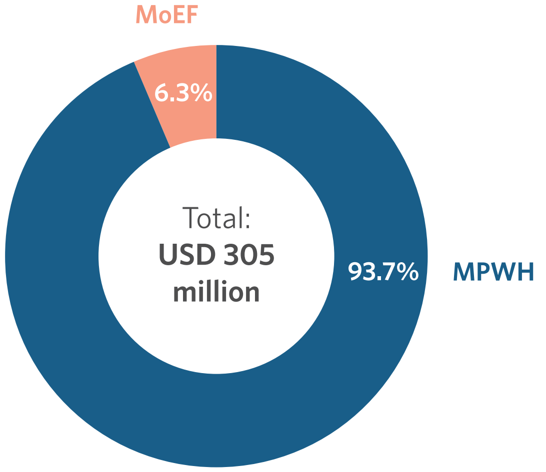
Funding originates from the State Budget (APBN), which channels public funds to both the MPWH and MoEF (now MoE) for their respective SWM programs/activities. The APBN also channels funds to regional governments through their respective regional budgets (APBD). At the regional level, the provincial budget (APBD-Provinsi) finances service units responsible for managing SWM at the provincial level. Similarly, city budgets (APBD-Kota) fund city service units to oversee district waste management infrastructure. In addition to city-generated revenue, such as local taxes, APBD-Kota also receives financial support from the provincial government through Provincial Support (Bantuan Provinsi).

PUBLIC FINANCING PROFILE

Of Indonesia's USD 305 million budget for SWM between 2016 and 2022, the MPWH managed around 93%. The MoEF managed the remainder, mostly for non-infrastructure programs.

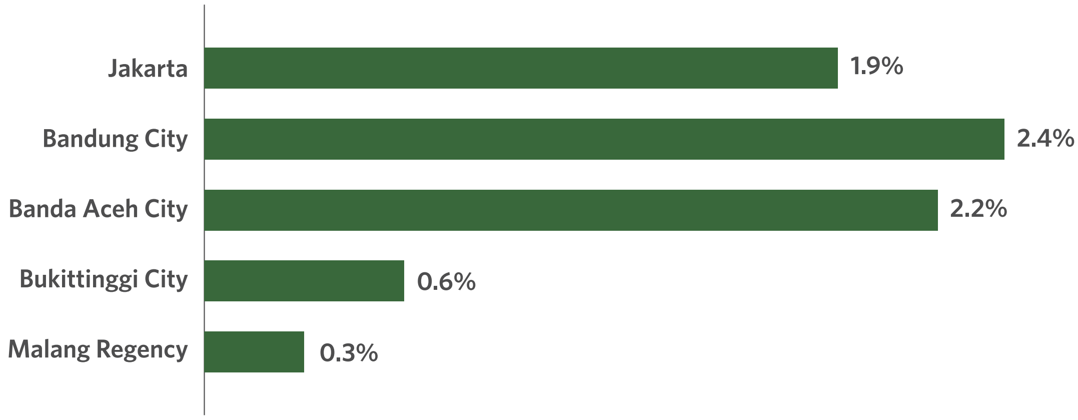
5 Based on the funding flows in the previous government/cabinet structure and subject to revision.

Figure 2: Central government spending on SWM (2016-2020)



At the city level, municipal government expenditure on SWM varies by city and population size. Figure 3 illustrates considerable disparities in the proportion of budgets dedicated to municipal SWM (MSWM), reflecting varying levels of prioritization and financial capacity for such services among cities.

Figure 3: Average regional government spending allocation on MSWM (2020-2022)[6]



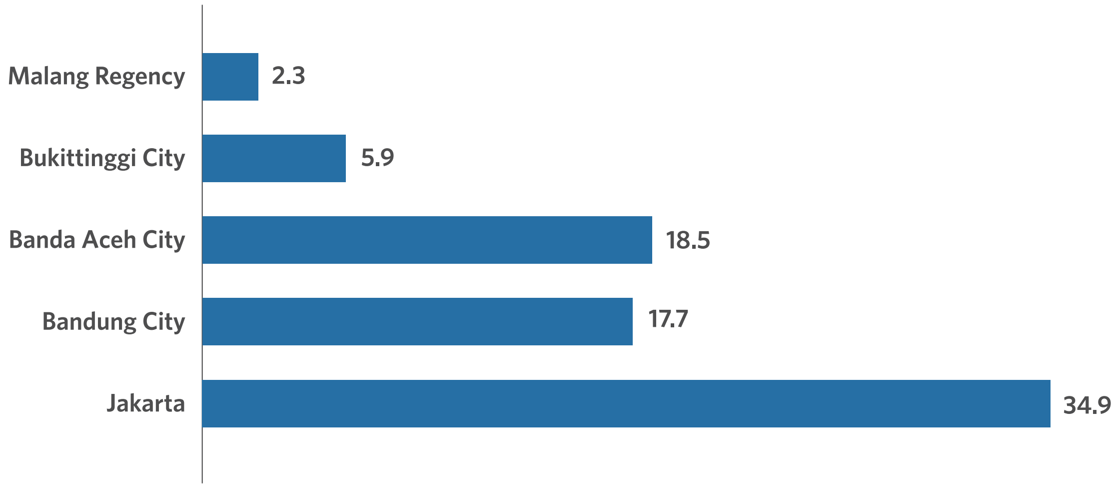
Source: *Study of solid waste management financing in Indonesia (Danish Ministry) 2020, Regional Budgets 2020–2022, SIPSN website (KLHK) 2024*

Malang Regency allocates the smallest share of its budget to MSWM (0.3%), followed by Bukittinggi City (0.6%), both far below the national average of 2%. Jakarta, Indonesia's capital, allocates 1.9%. In contrast, Banda Aceh City allocates 2.2% and Bandung City tops this list with 2.4% of its budget allocated to MSWM.

6 There are variability of availability of publicly accessible data for regional spending on SWM, different fiscal years are used. Malang Regency: 2015–2019, 2021–2022; Bukittinggi City 2014–2019; Banda Aceh 2014–2018; Bandung City 2020–2022; Jakarta 2019–2022.

The cost to process waste, measured in USD per tonne, reveals variations across cities, reflecting the interplay between budget allocations and waste management efficiency. When analyzed in conjunction with the percentage of city budgets allocated to MSWM, a pattern emerges that links spending commitment to the financial and operational efficiency of waste processing systems.

Figure 4: Average regional government spending per tonne of waste



When comparing the percentage of regional spending allocated to MSWM with the cost of waste processing (USD per tonne), a general correlation between the two variables emerges. The data suggests that cities with higher budget allocations tend to experience higher costs per tonne. This may reflect the financial demands associated with more advanced MSWM systems, which often require significant investment in infrastructure, technology, and operational capacity.

Cities with lower budget allocations and processing costs likely adopt a limited approach to waste management, focusing primarily on basic collection services with little or no advanced processing. This approach may indicate constrained operational capacity or underdeveloped infrastructure, resulting in lower costs but potentially reduced effectiveness or environmental sustainability.

However, the relationship between these variables is not strictly linear. For example, Jakarta incurs the highest cost per tonne despite allocating a smaller percentage of its budget to MSWM than Bandung. This discrepancy suggests that factors beyond budget allocation, such as urban density, waste generation volumes, logistical challenges, or inefficiencies in service delivery, can significantly influence the cost per tonne.

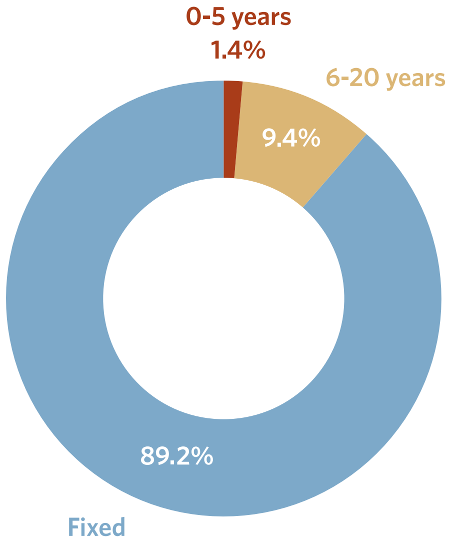
2.1.2 CASE STUDY FINANCIAL ANALYSIS

ASSET AND OPERATIONAL COST ANALYSIS IN BANDUNG SAMPLE

The financial and operational sustainability of sampled SWM entities in Bandung are influenced by their asset structures, waste processing volumes, and cost compositions. These factors shape their operating expenses per tonne of waste and highlight key disparities between private-, government-, and community-operated entities.

As shown below, the asset structure of SWM entities is dominated by fixed assets (89.2%), which provide the foundation for SWM operations.

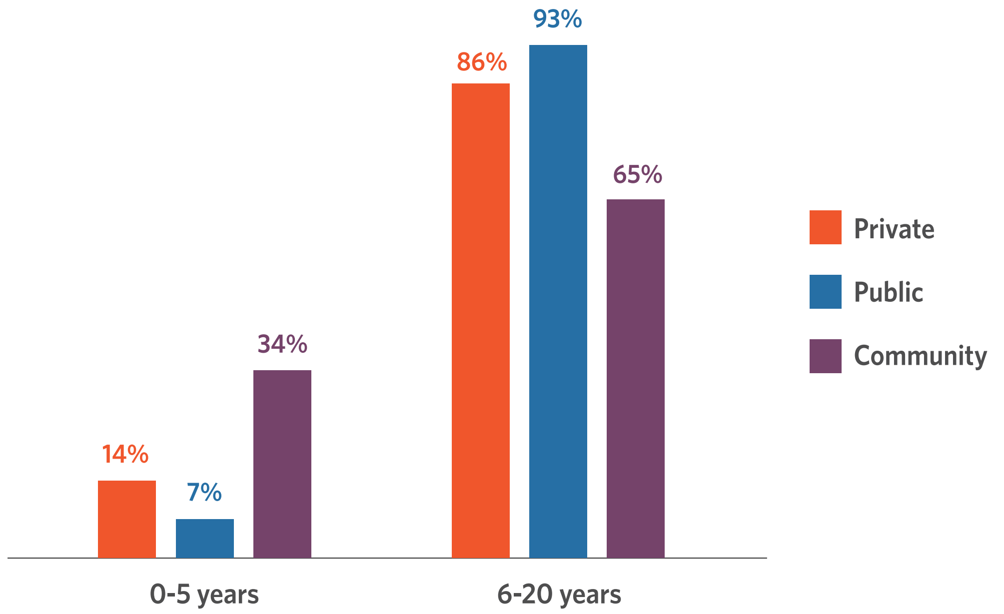
Figure 5: Asset value share for SWM activities grouped by lifetime use



However, excluding fixed assets from our analysis, short-term assets (0–5 years) make up a larger proportion for community groups (34%) than for private entities (14%) and government-operated entities (7%), implying frequent replacement cycles and recurring costs for community groups, as shown in Figure 6.

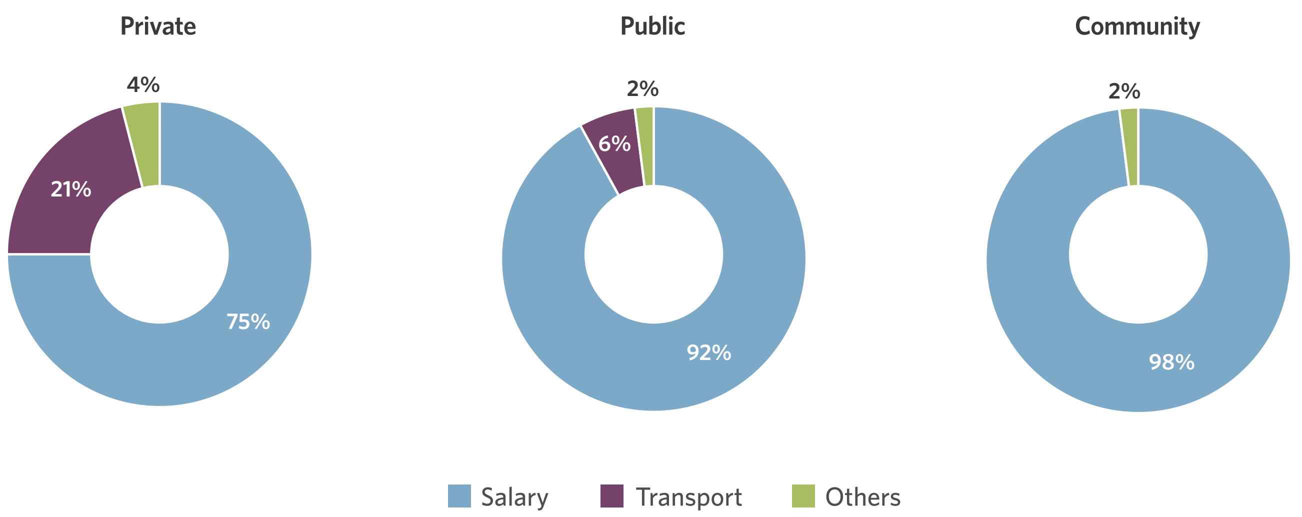
Figure 6 also shows that government-operated entities have the largest portion of assets in the 6-20 years range (around 93%), followed by private sector entities at 86%, and community groups at 65%. This indicates that public and private entities invest more in long-term assets, while community groups use assets over shorter periods, likely leading to more frequent replacements.

Figure 6. Portion of asset value by lifetime use (excluding fixed assets), by entity type



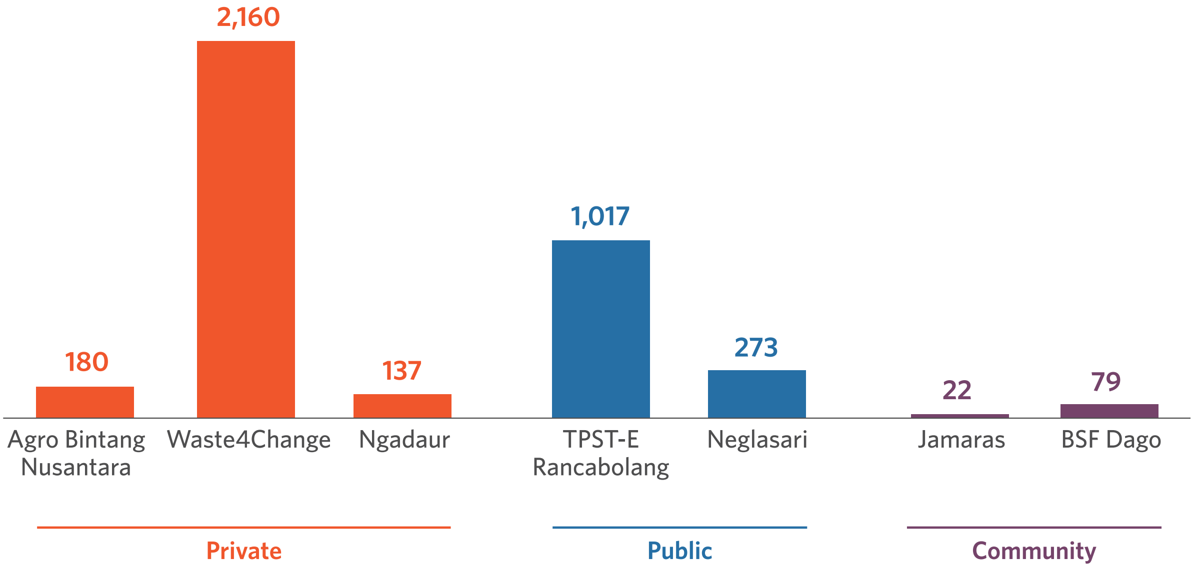
Private entities' expenses are divided between salaries (74.8%) and transport (21.2%), reflecting efficient cost allocation strategies that leverage economies of scale. Government entities' expenses largely pertain to salaries (92.0%), with minimal expenditure on transport (6.2%). Community groups spend 98% on salaries, with negligible other costs.

Figure 7: Operational cost composition by entity type



Despite higher operational costs, private entities processed significantly larger volumes of waste. As shown in Figure 8, this allows them to achieve greater economies of scale. On the other hand, community groups, which processed much smaller volumes, incurred higher operational costs per tonne than other groups.

Figure 8: Annual volume of waste processed by entity type (tonnes)



As further shown in Figure 9, the disparity in waste volumes and associated costs directly correlates with the financial strain community groups face in efficiently scaling operations. While private entity Waste4Change maintains lower operating costs per tonne than the government entity Neglasari, community group Jamaras faces higher costs.

Figure 9: Annual operating expenses per tonne of waste by entity type (USD/tonne)

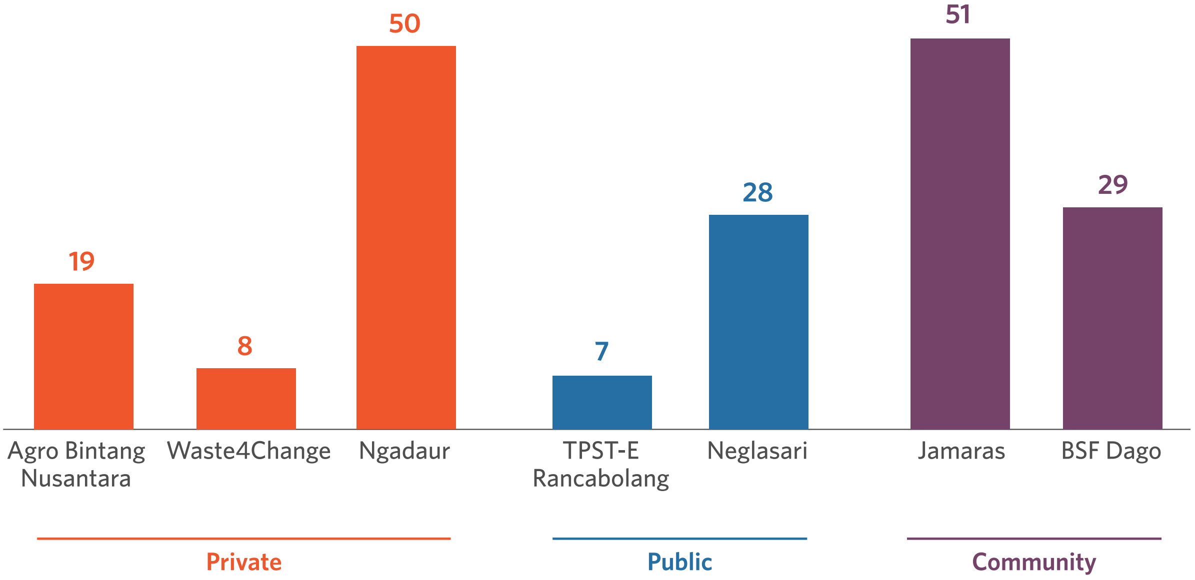
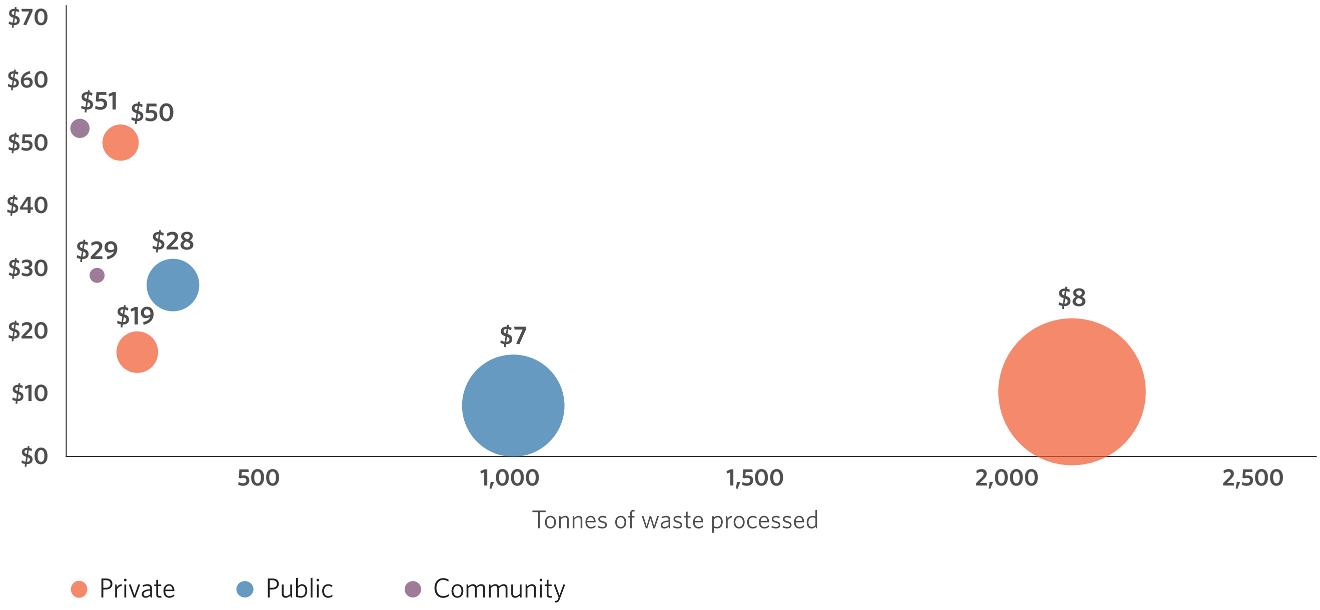


Figure 10 combines the data from Figures 8 and 9 by plotting annual waste volumes against operational expense per tonne, with bubble size reflecting the overall scale of operations. In general, larger-scale facilities tend to achieve lower costs due to economies of scale—illustrated by the government-run site at around 7 USD/tonne and a large private facility at around 8 USD/

tonne. However, the pattern is somewhat scattered: one government-operated facility achieves a cost lower than a private facility despite processing a smaller volume, indicating that factors beyond scale—such as business model, operational efficiency, and resource management—can also significantly influence costs.

For community-based or smaller-scale initiatives, the data mostly show higher costs, yet some smaller operations come close to more cost-competitive levels. This suggests that targeted improvements in process optimization, resource allocation, and technology could help these community-led efforts enhance cost efficiency and remain competitive in solid waste management.

Figure 10: Operational costs (USD/tonne) by entity type



FUNDING STRUCTURES AND FINANCIAL CHALLENGES

The financial sustainability of the SWM entities in Bandung is tied to their funding structures, which interplay with their asset utilization and operational dynamics. The funding profiles of private-, government-, and community-operated entities illustrate disparities in their financial capacity and resilience.

Private entities use self-generated funds for capital and operational expenses, as shown in Figures 11 and 12. This reflects their ability to recover costs through service revenues, enabled by efficient operational models that balance costs and leverage economies of scale. As seen in the previous section, private entities' high processing volumes and longer-lived assets contribute to cost-efficient operations.

Government-operated entities, in contrast, depend primarily on public funds, which cover 98% of their capital and 50% of their operational costs. They rely on continuous government support to maintain their labor-intensive models and mid-range processing volumes.

Figure 11: Source of capital funding by entity type

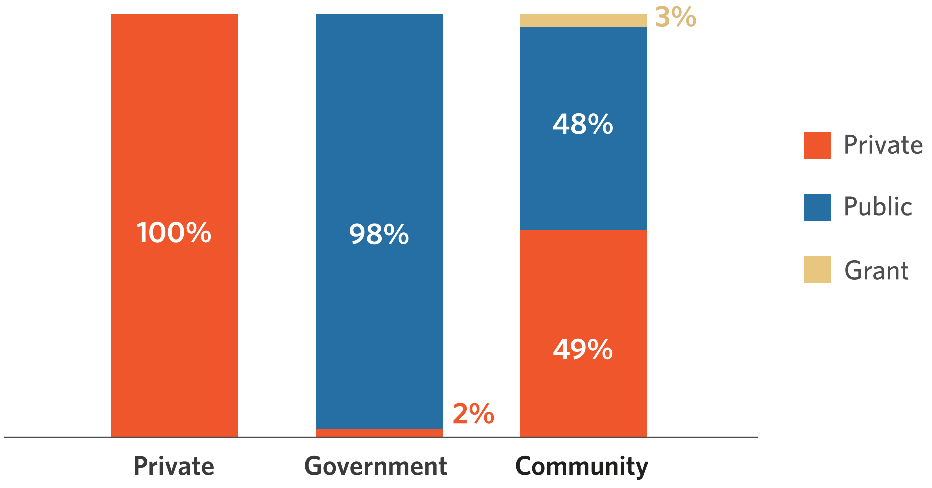
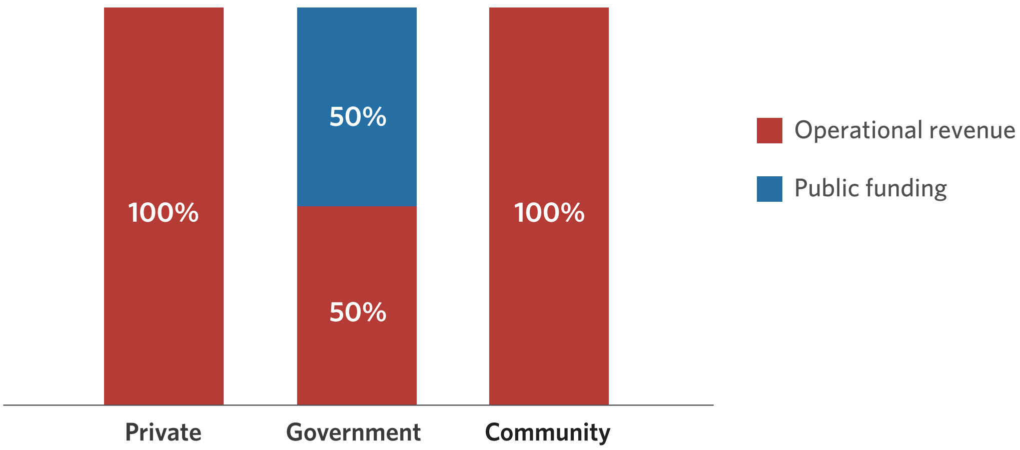


Figure 12: Source of operational funds by entity type

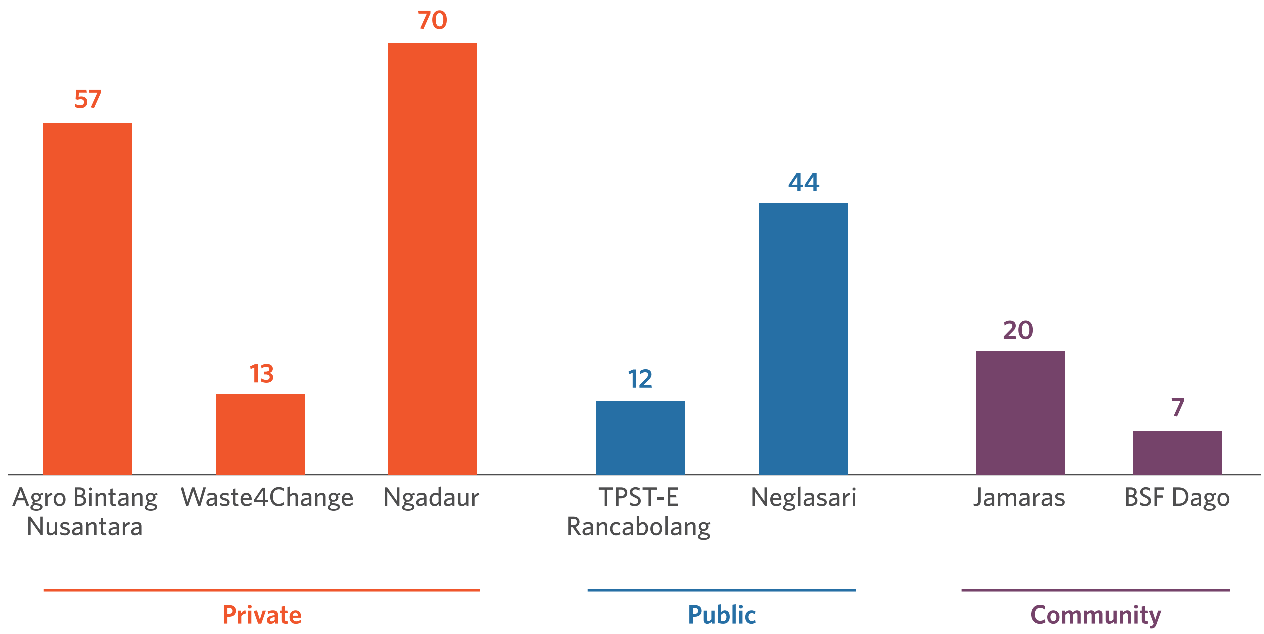


Community entities in our sample have the most complex funding structures, relying on a mix of finance from private entities (49%) and government (48%), as well as grants from corporate social responsibility (CSR) and philanthropic sources (3%) for capital expenditures. However, operational funding is mostly derived from their operational revenues, and/or contributions from the community operator, reflecting limited external financial support. This can create financial strains, especially given their small processing volumes and high labor dependency, which raise operating costs per tonne. The reliance on shorter-lived assets, highlighted in the operational analysis, further increases their need for recurrent capital inflows, placing pressure on their funding mechanisms.

Figure 13 highlights that private entities generate significantly higher revenues per tonne of waste. Ngadaur and Agro Bintang Nusantara achieve USD 70/tonne and USD 57/tonne, respectively, due to their larger scale and operational efficiency. Waste4Change, despite processing a much higher volume of waste (2,160 tonnes), generates relatively low revenues of

USD 13/tonne, with less efficient revenue generation per unit than private entities. Government entity Neglasari generates moderate revenue (USD 44/tonne), while community groups Jamaras and BSF Dago have much lower revenues (USD 20/tonne and USD 7/tonne), reflecting the financial constraints and heavy reliance on external funding.

Figure 13: Annualized operating revenues per waste volume of sampled SWM entities (USD/tonne)

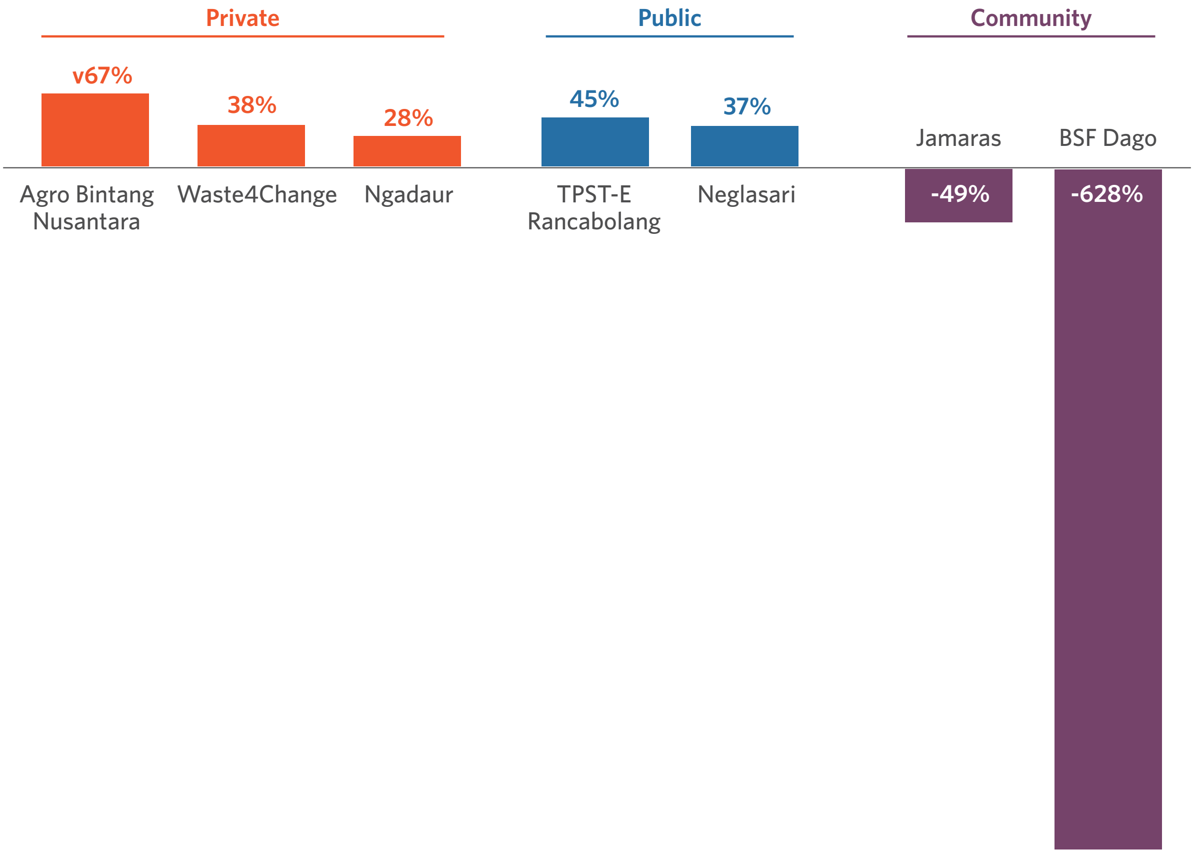


Operating margins further highlight the financial vulnerabilities of community entities. While private and government entities maintain strong margins of 28-67% and 37-45%, respectively, community groups show severe deficits. Jamaras had a margin of -49%, and BSF Dago had a margin of -628%.

Government facility TPST-E Rancabolang receives around USD 1,500 per year from the district government, which also provided one-off funding of USD 8,500 in 2023. Community groups do not receive such support or collect retribution fees from the households and neighborhoods they serve.[7] Rather, they rely on revenues from circular economy practices, such as BSF maggot cultivation and catfish farming. Despite minimal support, community groups independently treat approximately 15% of the community waste, which would otherwise be handled by government-operated facilities, highlighting a gap between their contribution to waste reduction and the support they receive.

7 Rukun Warga (community associations) and Rukun Tetangga (neighborhood associations).

Figure 14: Operating margins of sampled SWM entities

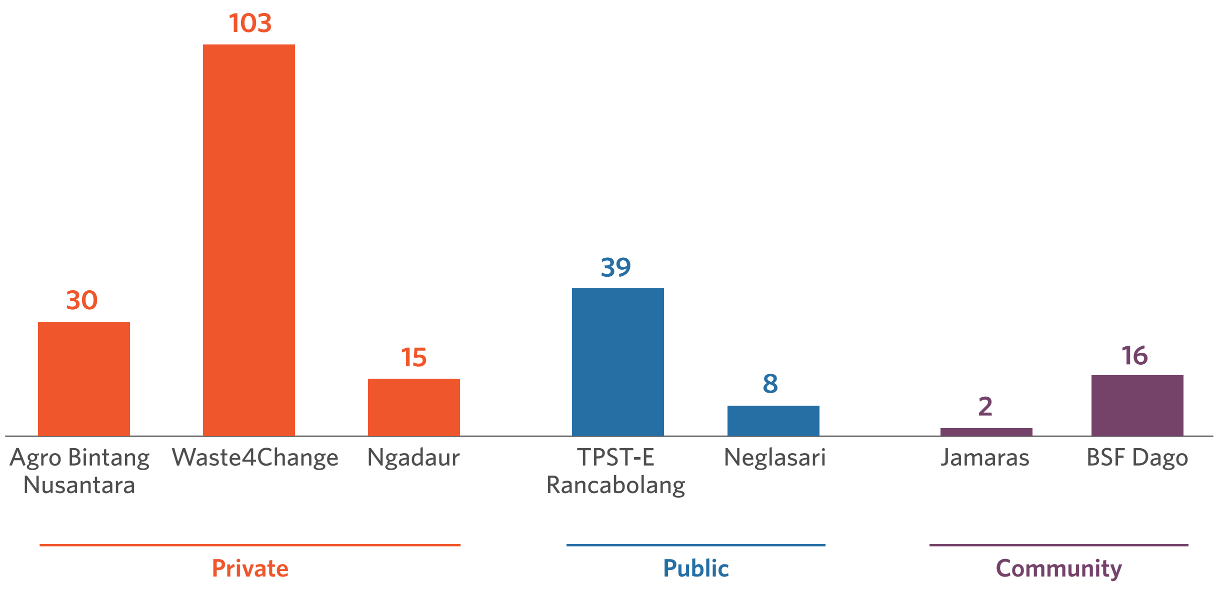


COST EFFICIENCY AND PRODUCTIVITY INSIGHTS

Bandung's sampled SWM entities have disparities in cost efficiency and productivity, which are tied to their operational scales, funding structures, and asset profiles. Building on the operational and financial challenges discussed above, this section examines the productivity metrics and levelized costs of waste management (LCOW) across private, government, and community entities to enhance understanding of their financial sustainability.

The annual waste volume processed per worker, shown in Figure 15, indicates significant disparities in labor productivity across entities. Private entities demonstrate the highest productivity, with Waste4Change processing 103 tonnes/worker annually. This is supported by their large operational scale, well-distributed workloads, and access to durable, long-term assets. Government entities have moderate productivity, with TPST-E Rancabolang achieving 39 tonnes/worker, reflecting a labor-centric model supported by consistent funding. Community entities show significantly lower productivity, with Jamaras and BSF Dago processing just 2 and 16 tonnes/worker, respectively. This reflects their smaller operations and heavy reliance on labor, as noted in earlier sections.

Figure 15: Annual waste volume per entity (tonnes/worker)



The disparities in scale and productivity are mirrored in the LCOW, which is the total cost of investment (capital and operational expenditure) over the assumed lifetime of the facilities (20 years), divided by the total volume of waste being treated over the same period. Figure 16 shows LCOW segmented into investment and operational components, providing a comprehensive measure of cost efficiency. Private entities exhibit wide-ranging costs, with private entity Waste4Change achieving the lowest LCOW at USD 11/tonne, supported by high labor productivity and large processing volume. The other private entities, Agro Bintang Nusantara and Ngadaur incur higher costs at USD 82/tonne and USD 92/tonne, respectively, driven by increased investment requirements and smaller processing volumes.

The combination of scale, innovative waste credit mechanisms, and cost-effective operational management allows Waste4Change to maintain a competitive LCOW while fostering local community engagement. This is in part due to its large waste processing scale (2,160 tonnes annually), which allows for efficient cost distribution, particularly for operational expenses (USD 8/tonne). It leverages diverse revenue streams from recycling, community partnerships, and innovative solutions such as waste credits, encouraging community involvement in waste collection to reduce operational costs.

Government entities maintain mid-range LCOW values, reflecting the balance between public funding support and moderate operational productivity. Between the two community entities, BSF Dago incurs higher costs (USD 63/tonne), driven by elevated investment and labor requirements, Jamaras achieves a competitive LCOW of USD 28/tonne. This relatively low cost, despite operational inefficiencies, reflects the potential for cost-effective community waste management, particularly when investment requirements are minimized and operational models are optimized.

Figure 16: Levelized cost of waste management by composition per entity

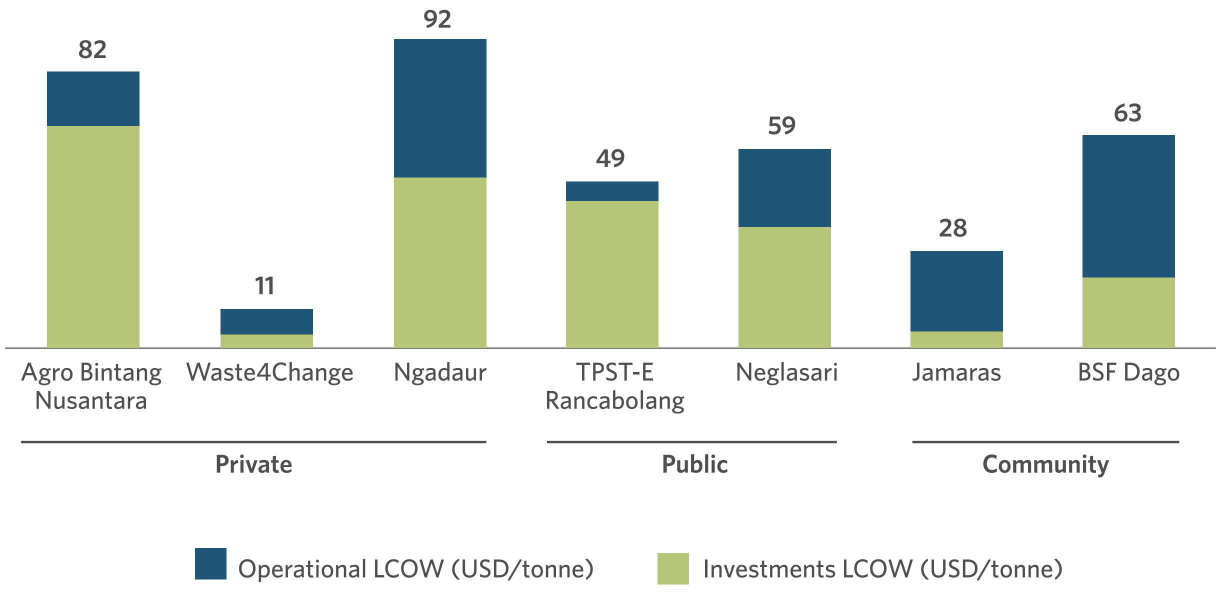
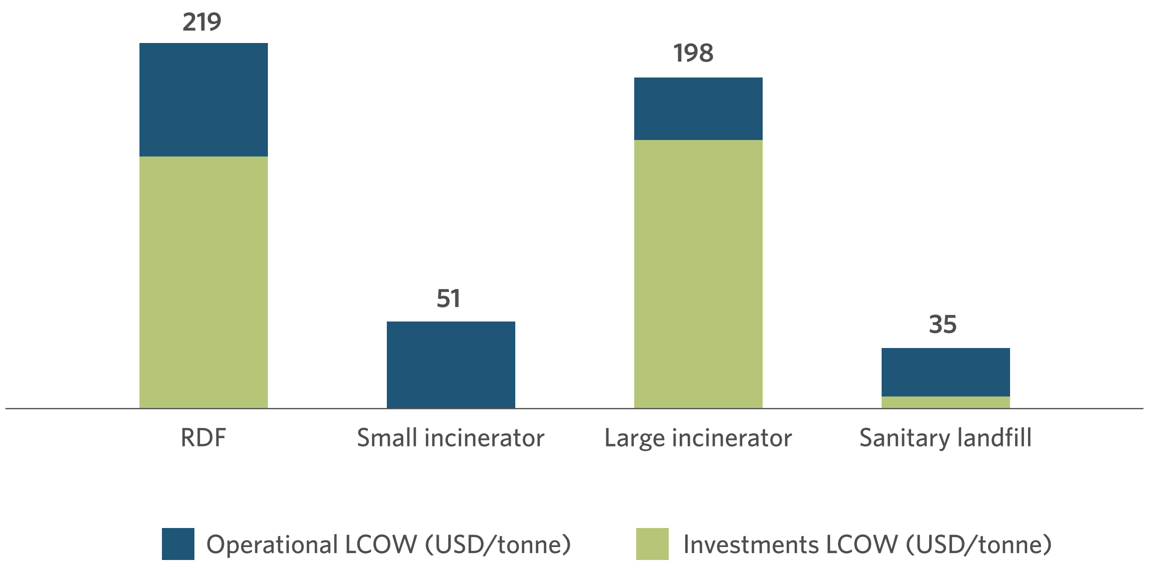


Figure 17 shows that capital intensity dominates LCOW: for both RDF and large incinerators, roughly 80–90% of the total LCOW is upfront investment. Compared with the entity-level LCOWs in Figure 16, community-scale models have lower LCOW than these high-capex technologies and can compete head-to-head with small incinerators and sanitary landfills.

Figure 17: Levelized cost of waste management by composition per technology



The analysis highlights the critical roles of operational scale and productivity in determining cost efficiency. While private entities capitalize on economies of scale, the performance of Jamaras suggests that community models could also achieve scale with targeted interventions. By addressing operational inefficiencies and leveraging the inherent advantages of community-driven systems, community SWM holds the potential to achieve competitive LCOW.

2.1.3 CO-BENEFITS OF ORGANIC WASTE TREATMENT IN INDONESIA

Beyond reducing waste volume going to landfills and reducing methane emissions, organic SWM in Indonesia provides a wide range of financial, economic, social/community, health, and environmental co-benefits. When quantified, these co-benefits can make technologies more attractive for investment. These co-benefits are listed in the Appendix Table A.3.

2.2 BRAZIL

2.2.1 PUBLIC FINANCE ANALYSIS

OVERVIEW OF PUBLIC FINANCING GOVERNANCE FOR SWM IN BRAZIL

In Brazil, public funding for SWM operates in a decentralized governance framework, where municipalities have the primary responsibility for waste management services as mandated by The National Solid Waste Policy (PNRS) of 2010. While municipal governments have operational and financial autonomy in managing their SWM programs, they receive support through the Ministry of Environment and other federal funding schemes.

Each municipal government determines its SWM. The Federal Government primarily focuses on setting national guidelines such as the National Solid Waste Plan (Planares), providing technical support, and offering financing mechanisms through programs. State governments act as regulatory bodies and provide technical assistance. This report's analysis of funding focuses on the municipal government level in Brazil.

Organic waste management in Brazil

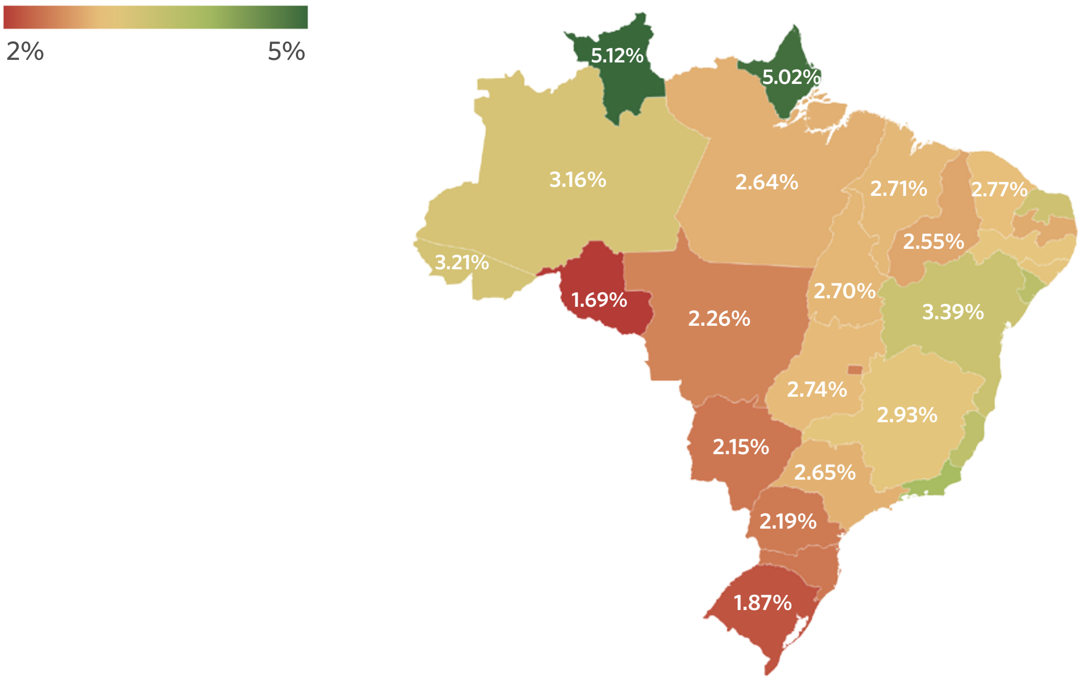
Credits (left to right): Prefeitura de Florianópolis, VerdeCoop, Angeoletto/CEPAGRO/Acervo Revolução dos Baldinhos

PUBLIC FINANCING PROFILE

Data from 2022 captured by The National System for Information on Basic Sanitation (SINISA) shows variation in municipal government expenditures for MSWM across Brazil, reflecting their differing fiscal capacities as well as Brazil's diverse landscape and varying urbanization patterns.

As shown in Figure 18, Most states in Brazil's North region (except for Rondonia) allocate the highest proportions of their municipal budgets for SWM, with Roraima and Amapa allocating 5.12% and 5.02%, respectively. This can be attributed to their infrastructure challenges and lower population density, which require higher per-capita investments. Meanwhile, states in the South allocate lower proportions of their budgets for SWM, ranging from 1.87% to 2.19%, due to their more established infrastructure and economies of scale for SWM. Most states in the other regions (Northeast, Centralwest, and Southeast) maintain moderate average allocations between 2.15% and 3.39% of the municipal budget for SWM.

Figure 18: Average municipal government budget/expense for MSWM (%) by states and federal districts



The data further shows variations in SWM budget allocations across Brazil's major cities; Figure 19 shows a range from 1.70% to 6.59% of municipal budgets. While Rio de Janeiro has both the highest budget allocation (6.59%) and one of the highest per-tonne costs (USD 133), São Paulo demonstrates greater operational efficiency with a moderate budget allocation (3.75%) yet maintains similar per-tonne costs (USD 128). Both cities have large populations, which suggests increased operational costs per tonne in more urbanized areas.

Figure 19: Municipal government budget/expense for MSWM (%) by city

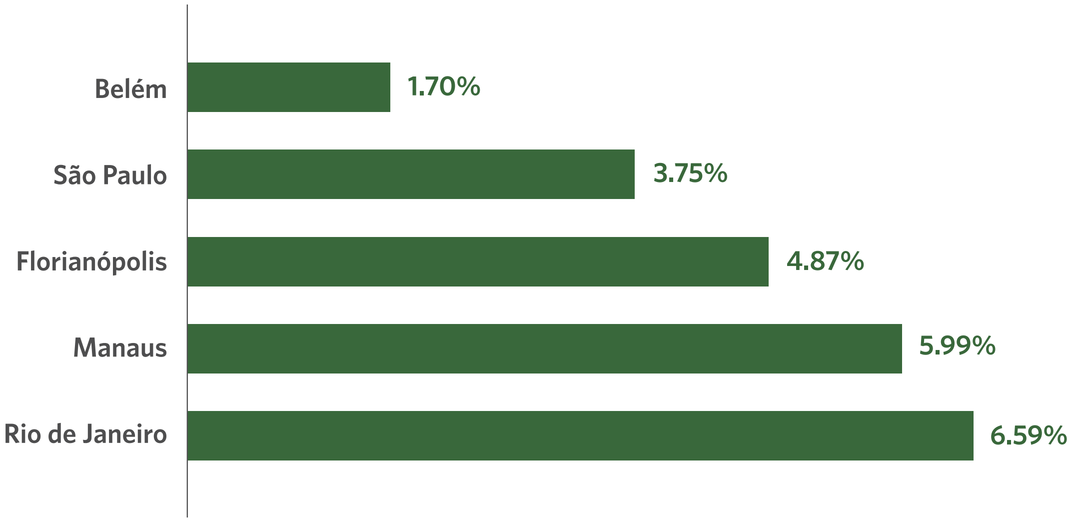
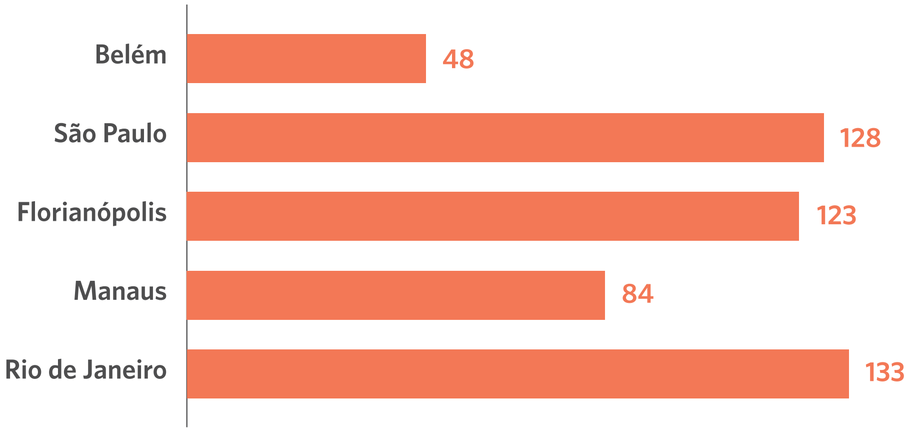
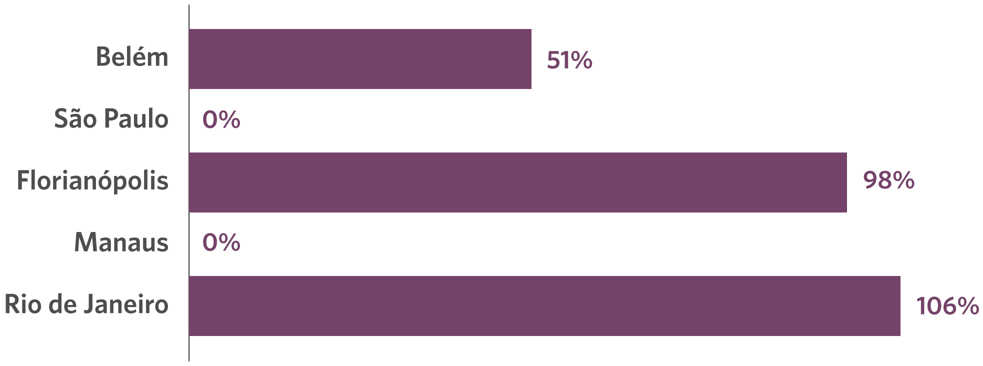


Figure 20: Average municipal government budget/expense for MSWM (USD/tonne)



The level of cost recovery through waste fees, as shown in Figure 21, reveals insights into MSWM financing strategies across Brazil. Rio de Janeiro has both the highest budget allocation (6.59%) and full cost recovery with a 106% waste fee-to-cost ratio, indicating a sustainable funding model. In contrast, São Paulo and Manaus report 0% waste fee collection, with complete reliance on general municipal funds rather than direct user fees.

Figure 21: Waste fee to MSWM cost ratio by city



Rio de Janeiro charges a specific waste charge inside land tax, enabling it to achieve financial self-sufficiency for MSWM. Waste fees entirely cover MSWM activities by the city and could offer lessons for other cities that have issues with waste retribution fee collection.

The waste fee for Rio de Janeiro is an annual fixed amount based on location group and charged along with land tax with exemptions applied based on land value. These fees are:

- BRL 95 - BRL 635 (USD 17.3 - USD 115) for residential areas
- BRL 236 - BRL 1,588 (USD 42.9 - USD 288.7) for non-residential areas

These variations highlight that while budget allocations are important, the efficiency of spending and local operational contexts play crucial roles in MSWM.

2.2.2 CASE STUDY FINANCIAL ANALYSIS

For cases in Brazil, Instituto Pólis gathered sample data from business models operating in the following municipalities: Araraquara, Entre Rios, Florianópolis, Lages, São Paulo, Santa Cecília do Sul, Sertãozinho, and Rio de Janeiro. The sample information details are provided in Appendix A.2. Instituto Pólis conducted the first three steps shown in the below figure (sample identification and two levels of screening).

Figure 22: Sample selection process for case studies

1 Identification of potential sample	2 1st screening	3 2nd screening	4 Preliminary sample analysis	5 Final group sample
Identifies potential business model in waste management in Brazil to be included.	Screening was conducted by Polis as per the following criteria: • The entity/business model is fully operational (not in pilot scale). • The entity/business model operates in city scale.	Data availability and quality	• Grouping was conducted based on its legal form. • Group with only 1 sample was excluded from group analysis. • Initial financial analysis was conducted to check significant difference over the sample within the same group.	**9 entities under 4 groups:** • Waste picker cooperative • Private corporation • Public with private operator • Public - home composting

For the fourth step—preliminary sample analysis—CPI grouped the various cases according to their legal form. These groups comprise the following models, reflecting different ways in which MSWM is operated in Brazil:

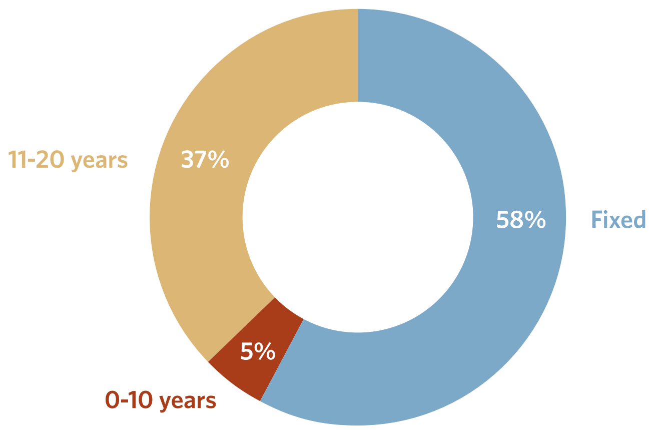
- **Waste picker cooperative:** An organized group of informal waste workers who collect and process waste through collective efforts.
- **Private corporation:** For-profit companies responsible for waste collection, processing, and disposal.
- **Public with private operator:** A partnership where the public sector sets policies and provides funding while a private company handles the operational aspects of waste management services.
- **Public - home composting:** A government-supported program supplying kits to households to compost organic waste at home.

ASSET AND OPERATIONAL COSTS ANALYSIS

A comparative financial analysis was conducted on the waste management entities' assets and operational costs to identify any disparities among them and to gain insights into their financial viability.

The analysis, based on data from interviews conducted in 2024, found that a significant portion of average investments across all sampled entities went to fixed assets, comprising 58% of total asset value and primarily consisting of land and buildings. This reflects the fact that some entities received in-kind support in the form of land provisions. In addition, 37% of investments were in medium-term assets (i.e., with an expected lifetime of 11-20 years), including equipment such as shredding machines and waste collection trucks. Due to the implementation of composting technologies that rely on longer-lifetime equipment like Material Recovery and Biological Treatment (MRBT), these types of assets represent a higher proportion (43% of total asset value) than the samples in Bandung (10%). The remaining 5% was allocated to short-term assets (expected lifetime of 0-10 years) such as buckets, chainsaws, and compostable bags, indicating a relatively small investment in frequently replaced tools.

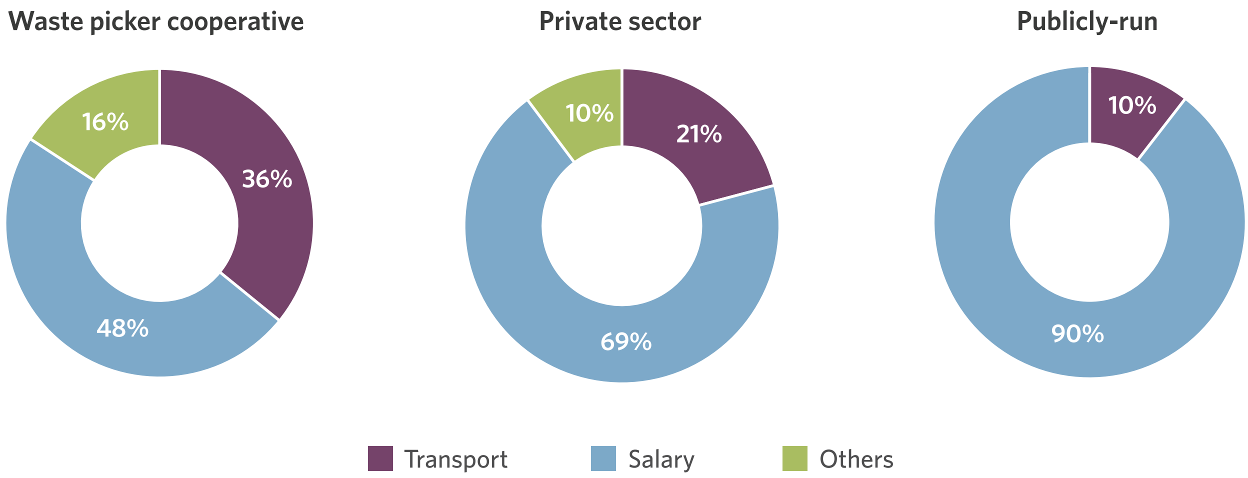
Figure 23: Asset value for MSWM by lifetime use in Brazil sample[8]



Organic SWM activities are often labor-intensive. As the operational cost compositions for the different business models below show, labor makes up the highest cost across different entities.

The case studies show entity-specific cost structures. Waste picker cooperatives have 48% of costs allocated to salaries, 36% to transport, and 16% to other expenses. Private operators have a higher emphasis on labor costs (69%), with reduced transport expenses (21%) and other operational costs (10%). Public operators have the highest salary allocation (90%), primarily because they contract out operations to private entities, including transport.

Figure 24: Operational costs for each entity in Brazil sample



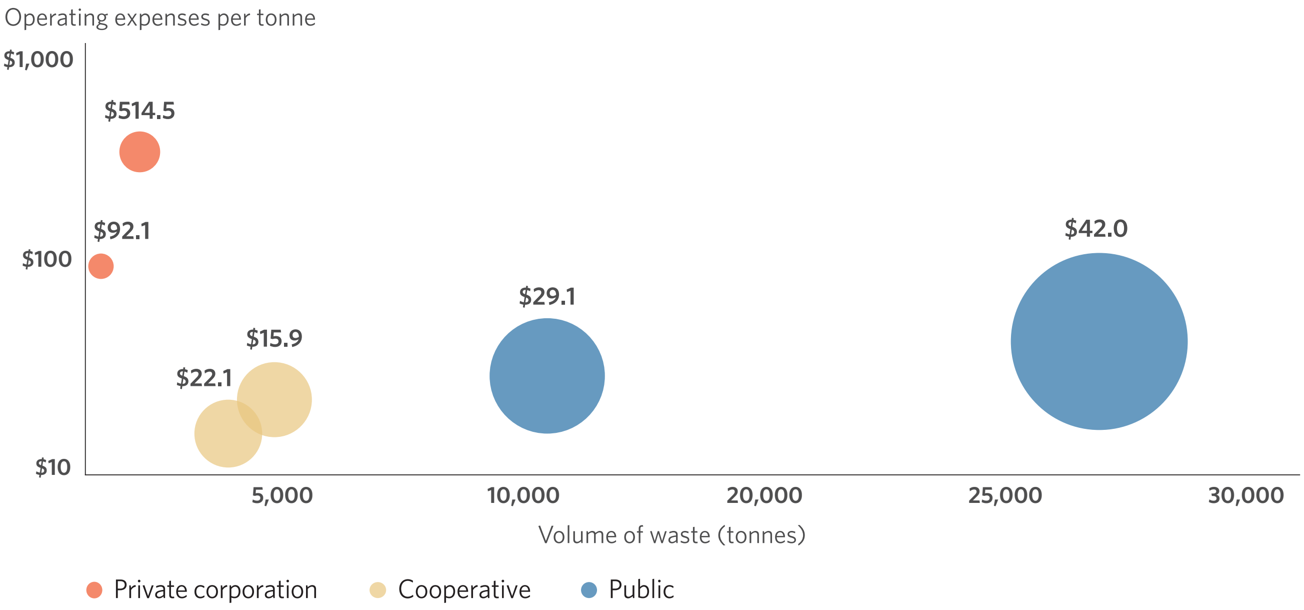
Note: *Public - home composting is not included in the figure, given that this activity incurs only a one-time expense.*

There are significant differences in operating costs across entity types. Private corporations have the highest operation cost range (USD 92.1-514.5/tonne), likely due to the lower volumes of waste that they process. Cooperatives have lower operating expenses (USD 15.9-22.1/tonne) for

8 We note that different periods are used to denote asset lifetimes across the Indonesia and Brazil cases. This is due to methodological differences between YPBB and Instituto Polis, which gathered the respective data.

moderate volumes of waste processing. Public entities' costs range from USD 29.1-42.0/tonne, with the highest volumes of waste.

Figure 25: Operational costs (USD/tonne) by entity type in Brazil sample



LCOW is used to assess the overall cost-effectiveness of various organic MSWM entities over their lifetime, as shown in Figure 26.

Figure 26: Levelized cost of waste management by composition in Brazil sample

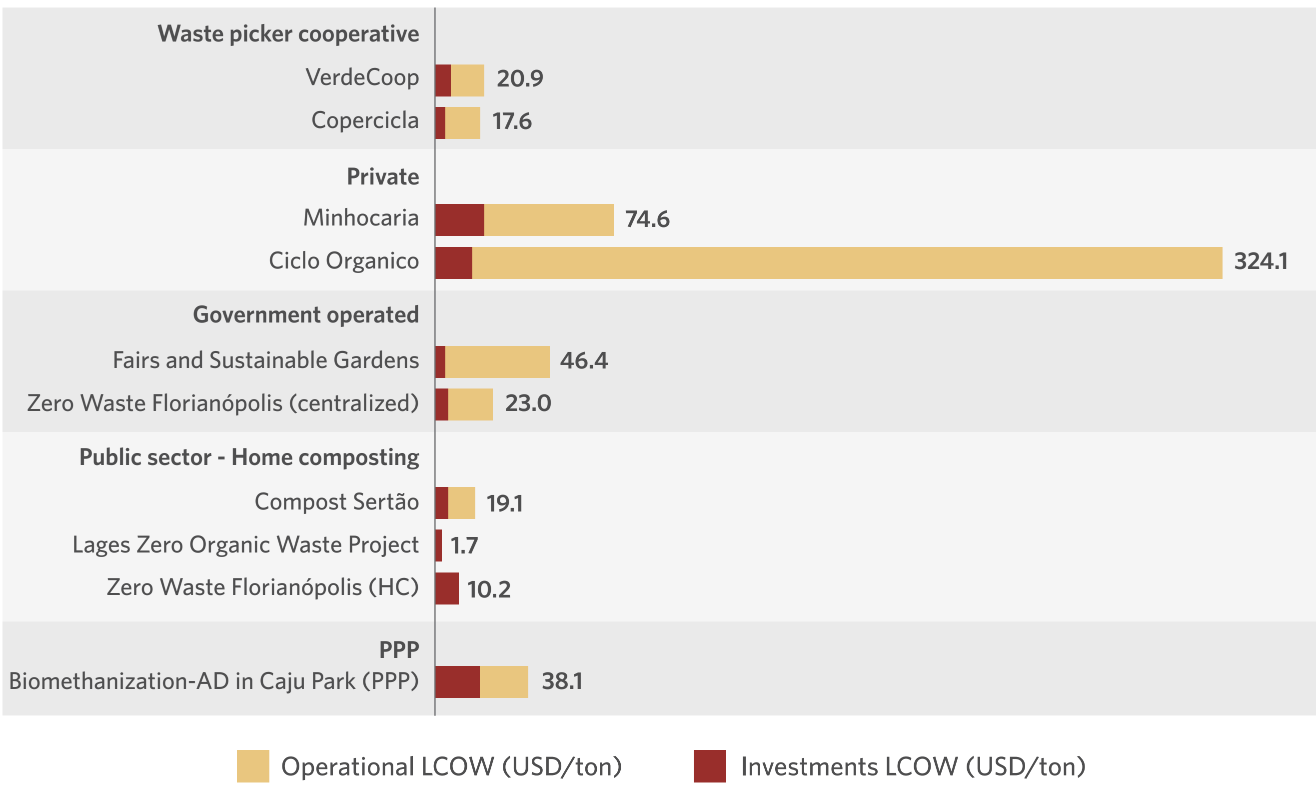
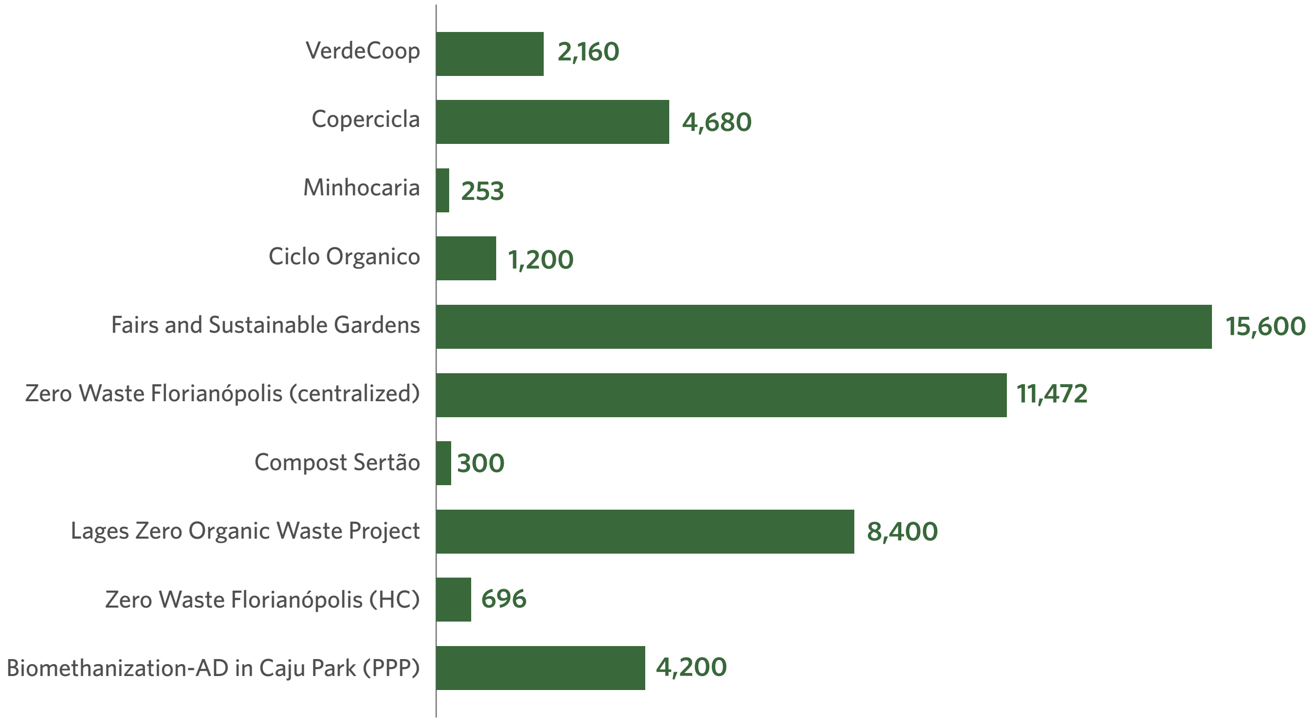


Figure 27: Annual waste volume by entity in Brazil sample (tonnes)



LCOW analysis found that private operators have the highest costs. Ciclo Orgânico records the highest at USD 324.1/tonne, primarily driven by operational expenses. This contrasts with the facilities of the government-run “Fairs and Sustainable Gardens”, with moderate costs of USD 46.4/tonne while processing substantially larger waste volume (15,600 tonnes annually). The most cost-efficient model from the samples is home composting, which achieves a remarkably low LCOW of USD 1.1-19.1/tonne. This is attributed to their minimal ongoing costs and lack of land requirements while processing large volumes of waste with only an initial investment in providing composting kits to households. Sampled waste picker cooperatives occupy the middle ground, with an LCOW of USD 17.0-20.9/tonne while processing moderate waste volumes of 2,160-4,680 tonnes annually.

The data shows an inconsistent relationship between operational scale and cost. For example, Coopercicla processes 4,680 tonnes annually at USD 17.63/tonne, while the Biomethanization-AD in Caju Park plant processes a similar volume of 4,200 tonnes for USD 38.09/tonne). Comparing SertãOzinho (300 tonnes at USD 19.12/tonne) to Minhocaria (253 tonnes at USD 74.65/tonne) further illustrates that similar operational volumes can have vastly different costs. This indicates that scale alone does not determine cost—local conditions and operational models may also play a role.

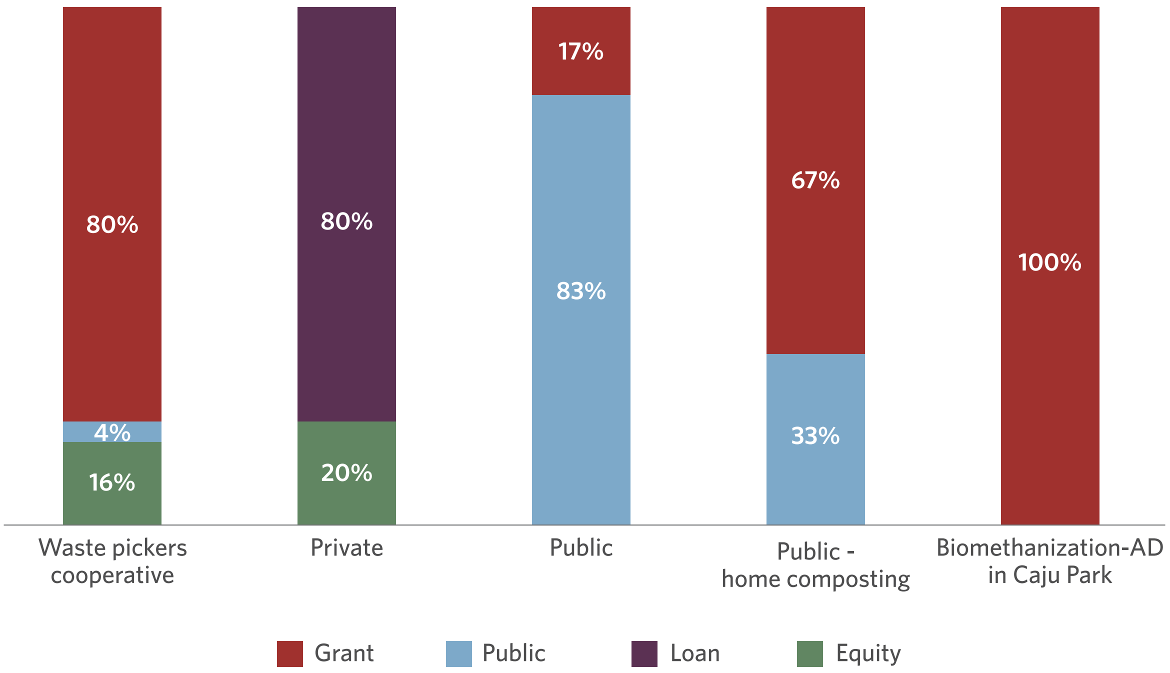
FUNDING STRUCTURES AND FINANCIAL CHALLENGES

Entity types in Brazil’s organic SWM sector have diverse funding structures. The variation in funding sources and financial performance demonstrates how different organizational models have different operational needs.

Waste picker cooperatives have the most diversified funding for capital expenditure, receiving 80% of their capital from grants, 16% from equity, and 4% from government support, as shown in Figure 28. This financial assistance is valuable for cooperatives that have limited access to traditional credit mechanisms.

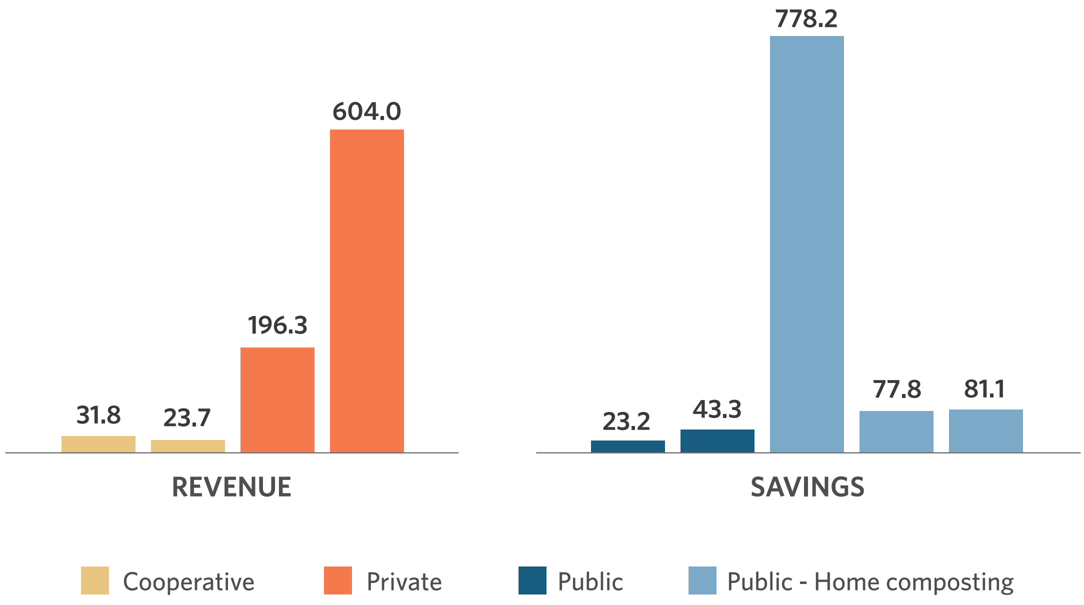
In contrast, private operators capital expenditure are mainly financed through loans (80%), reflecting their strong creditworthiness. Public entities, including MSWM and home composting initiatives, rely on government funding and grants. Sampled public facilities operate using 83% of government funding, with the remainder from grants. Lastly, home composting initiatives receive funding as philanthropic grants (67%) and government contributions (33%). The Biomethanization-AD in Rio de Janeiro was entirely funded by government grants, reflecting large infrastructure projects' reliance on public capital.

Figure 28: Source of capital funding by type in Brazil sample



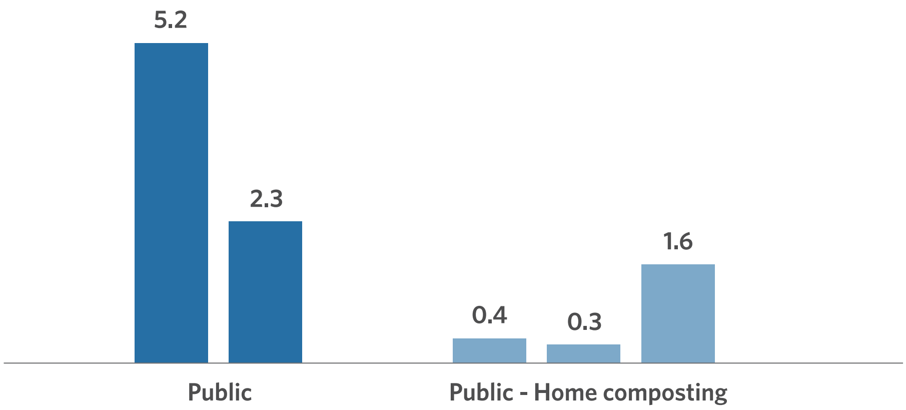
Regardless of funding structure, challenges persist across entity types. Waste picker cooperatives and public programs show lower revenue/savings than others. Figure 29 shows that cooperatives generate modest revenues (USD 24-32/tonne), making them highly dependent on grants and cost-saving measures. The private sector stands out for its ability to generate significant revenues (USD 193-604/tonne), far surpassing other entities.

Figure 29: Annualized revenue/savings[9] by entity type (USD/tonne)



Similarly, sampled public facilities often experienced low financial returns, as demonstrated by their lengthy payback periods[10] of up to 5.2 years (see Figure 30). In contrast, sampled home composting programs demonstrate shorter payback periods (0.3-1.6 years), largely due to their requirements for one-time upfront investment, with ongoing composting being conducted by households.

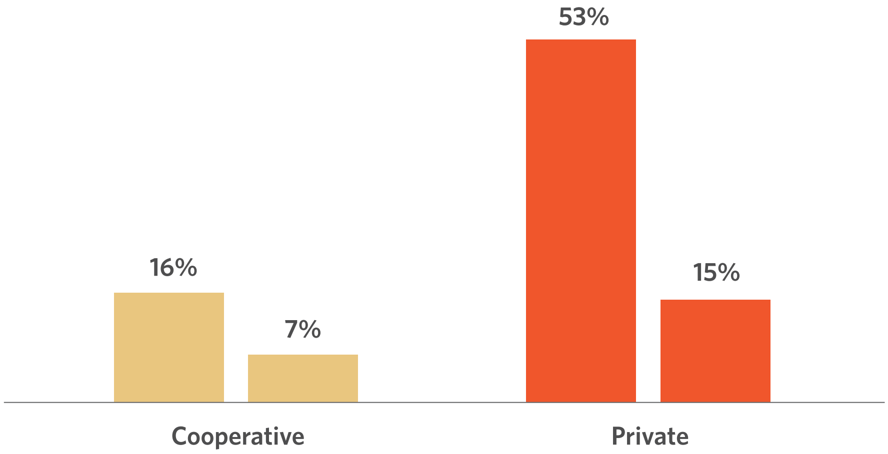
Figure 30: Payback period of savings to municipalities by entity type (years)



Analysis shows that waste picker cooperatives and private companies can cover their operating costs. While there are disparities in operating margins (shown in Figure 31), private entities have a higher range (15-53%) than cooperatives (7-16%), likely due to charging higher prices to a comparatively smaller market segment.

9 "Savings" refers to costs avoided when organic solid waste is diverted from municipal waste management systems, thereby reducing public expenditure.
10 The payback period measures how quickly initial investment is recovered through operational cost savings from avoiding traditional waste management facilities.

Figure 31: Annualized operating margin by entity type (%)



The disparity between revenue and savings potential in the private and public sectors highlights the challenge of ensuring financial equity across SWM systems. While private entities secure loans and achieve higher margins, public programs and waste picker cooperatives depend on grants and government support for operational viability.

2.2.3 CO-BENEFITS OF ORGANIC WASTE TREATMENT IN BRAZIL

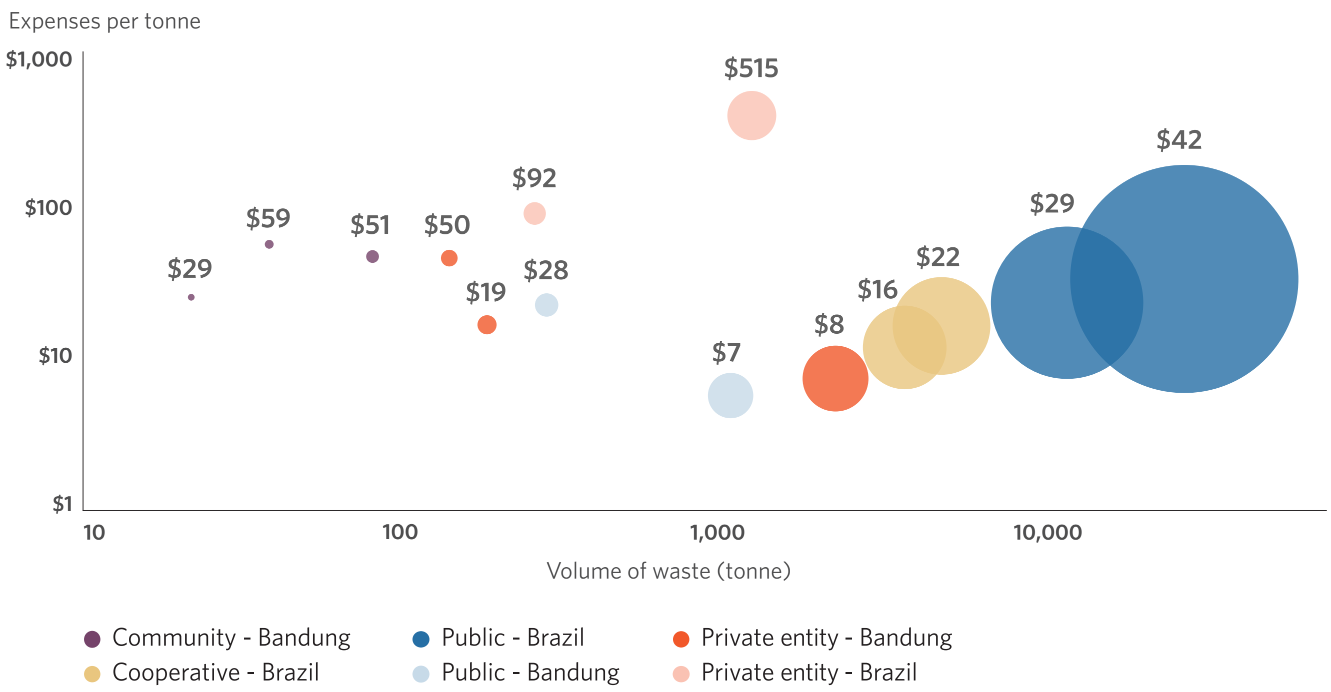
Similar to Indonesia, the benefits of organic waste treatment in Brazil span across the financial and economic to social/community, health, and environmental co-benefits; this can make the technologies more attractive for investment. See Appendix Table A.4 for a full list of co-benefits.

3. CONCLUSION

3.1 FINDINGS FROM FINANCIAL ANALYSIS

1. Higher waste treatment volumes do not always result in lower operational expenditure per tonne of waste. Other factors such as the larger size of operational area may raise operational costs (i.e., for transport and handling). Hence, there are potential operational cost efficiencies fo medium-sized, decentralized models with smaller operational areas and waste volumes. This is particularly apparent in the Brazil samples, where cooperatives can have lower operational costs per tonne of waste, as indicated in the figure below.

Figure 32: Operating expenses per tonne of waste for all samples

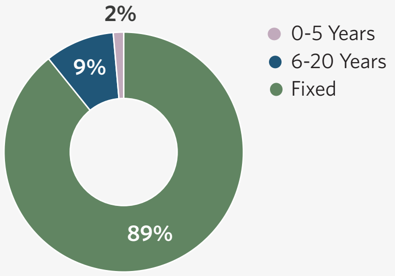


2. Capital expenditure for fixed assets (e.g., land acquisition) contributes the most to total asset value, as illustrated in the figure below, indicating that this can be a major barrier to entry for industrial players but less so for home composting.

Figure 33: Composition of assets in Indonesia and Brazil samples

INDONESIA

Asset value for SWM activities, by lifetime use

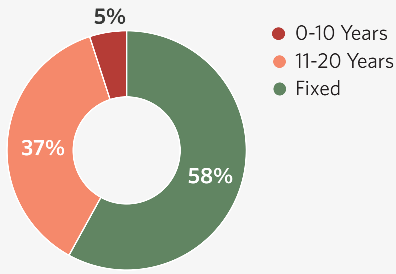


Some examples of assets in relation to their lifetime use

Lifetime Use	Assets
0 - 5 Years	Shovel, Compost Bags, Maggot Box
6 - 20 Years	Shredding Machine, Biopond, Trash Motorbike
Fixed	Land, Buildings

BRAZIL

Asset value for SWM activities, by lifetime use

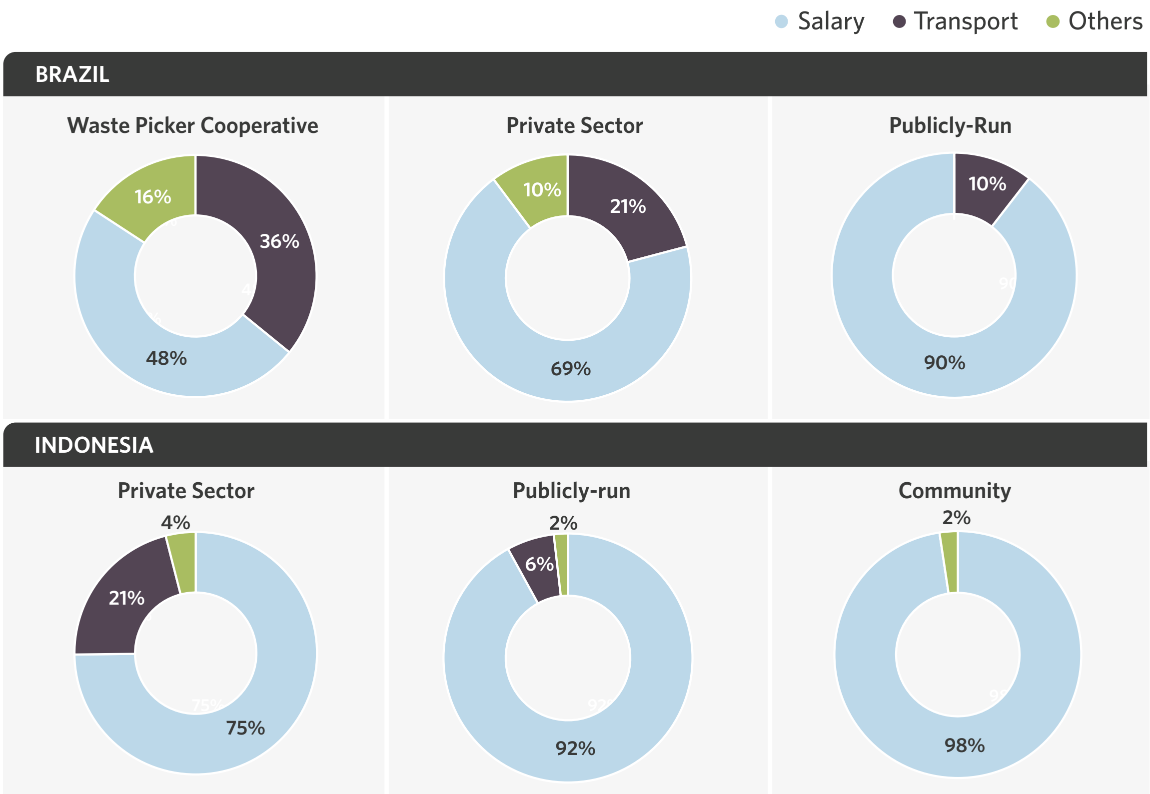


Some examples of assets in relation to their lifetime use

Lifetime Use	Assets
0 - 10 Years	Buckets, Chainsaw, Compostable bags
11 - 20 Years	Shredding Machine, Waste collection truck
Fixed	Land, Buildings

3. Labor accounts for the bulk of operational costs, accounting for 75-98% of these expenses in the Indonesia cases and 48-90% in Brazil. This shows that organic SWM is labor-intensive and can create jobs.

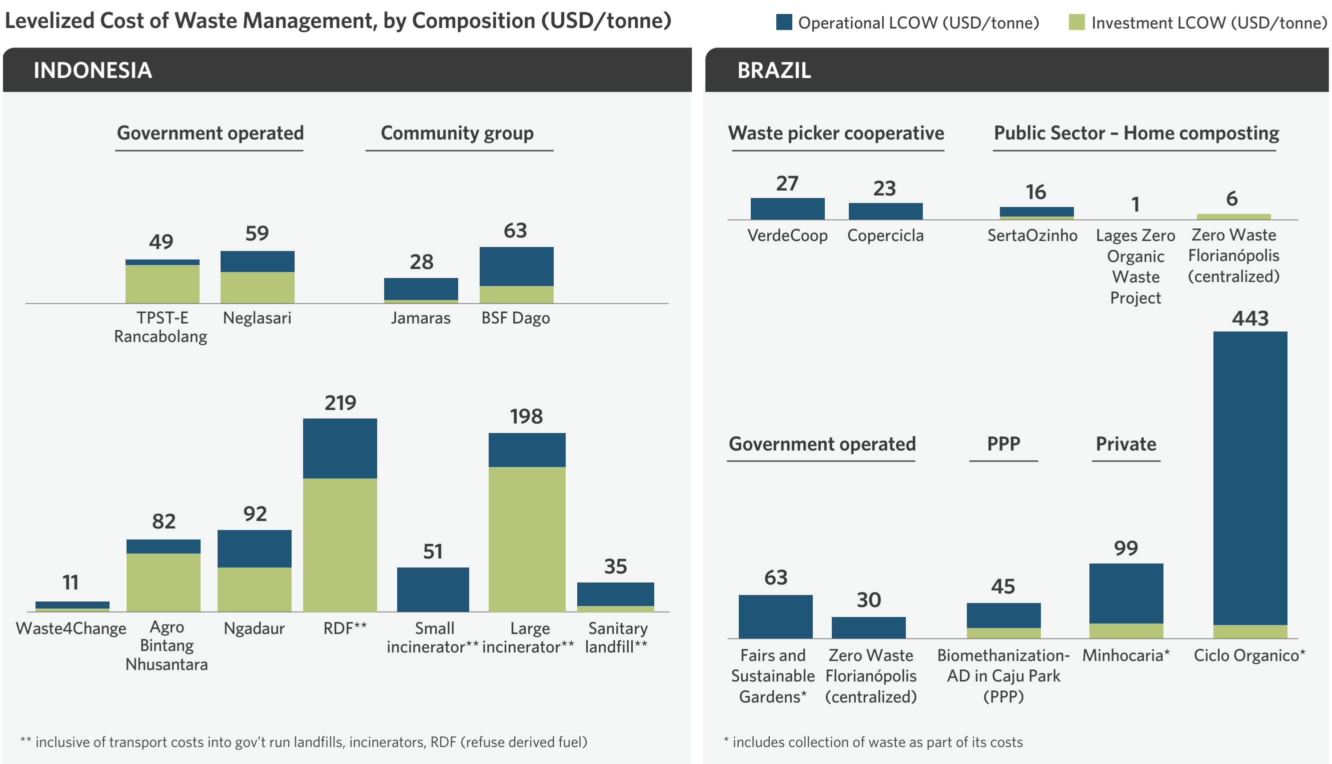
Figure 34: Composition of operational costs in Indonesia and Brazil samples



***Notes:** Public - home composting was not included as these incur only a one-off expense..*

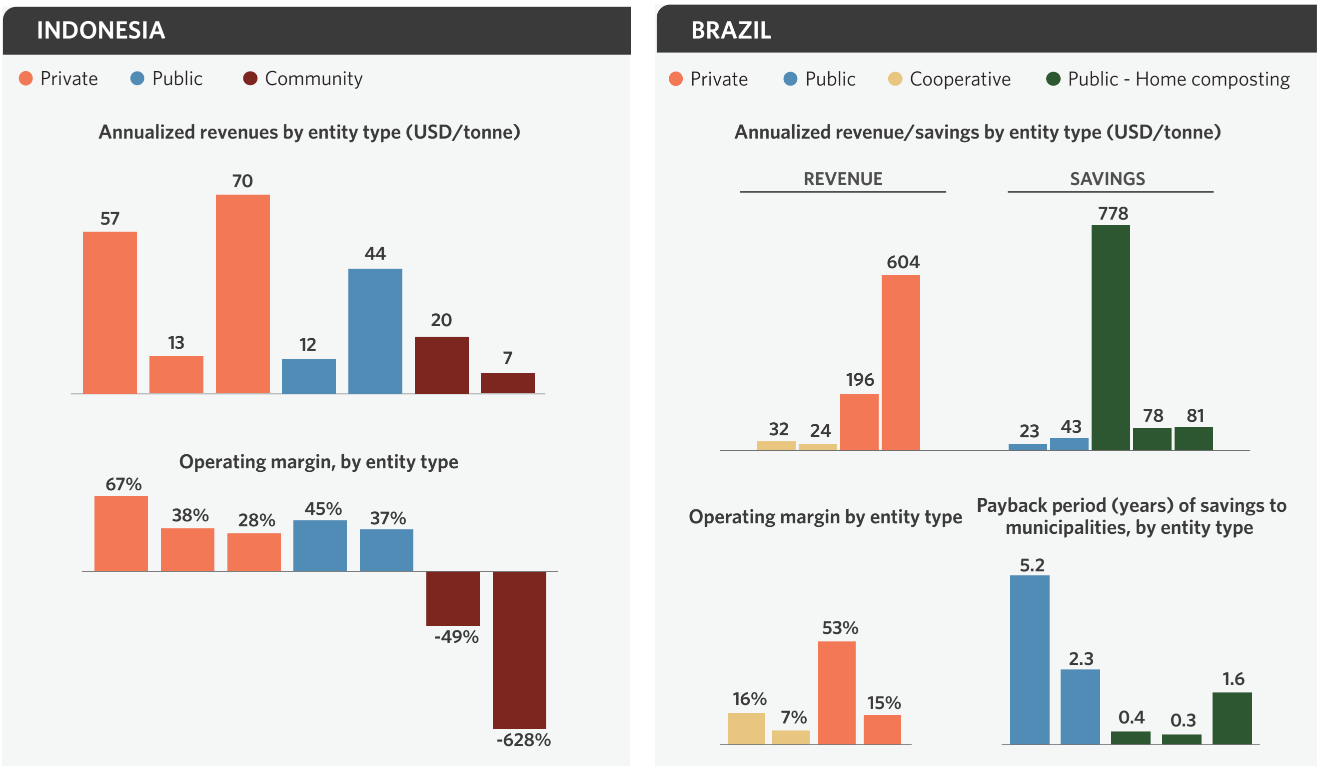
Community SWM and Public - home composting can be cost-competitive. If LCOW is used as the cost indicator, the sample data from community groups in Indonesia show competitive results compared to other business models, including those using incinerators and RDF (based on data provided by YPBB). For Brazil, the average LCOW of the Public - home composting model is lower than other business models.

Figure 35: LCOW in Indonesia and Brazil samples



4. The cost savings from diverting organic waste from landfills are attractive yet not always quantified. Data and information on cost savings are only provided by the public waste management model in the Brazil sample and not in the Indonesia sample.

Figure 36: Financial performance by entity type



3.2 FINANCIAL CHALLENGES AND OPPORTUNITIES

The case study analyses conducted in Indonesia and Brazil reveal similar challenges in financing organic solid waste management, as well as opportunities that can be explored to address them, as outlined in the table below.

Financial challenges	Related opportunities
1. Insufficient public budget for SWM	i. Linking waste fee collection to existing fee/tax collection mechanisms that have proven effective (e.g., land tax, utility bills). ii. Involving community groups in waste retribution fee collection and/or implementing cashless payments (e.g., via QR codes or electronic wallets). iii. Implementing clear and transparent budget-saving indicator(s) as a result of implementing a waste management strategy, such as providing home composting kits or facilities and technical assistance to community composting groups. This can justify further spending on SWM infrastructure, especially in the early stages of involving the public, community groups, and waste picker cooperatives in SWM. iv. Linking payments to the volume of waste generated by households to encourage them to reduce/treat their waste internally and generate compensation for the waste collected. v. Linking MSWM budgets with those of other sectors, such as health. vi. Exploring municipal/green bonds or sukuk to finance SWM infrastructure and equipment. vii. Exploring the potential use of carbon credits from emissions reduction resulting from better waste management, such as from the carbon market or an Article 6 initiative.

Financial challenges	Related opportunities
2. Financial feasibility of waste management projects/ business models.	i. Working with philanthropies and NGOs to provide technical assistance for community groups and waste picker cooperatives to improve their management and bookkeeping skills so they can be more financially sustainable. ii. Working with development banks and donors to explore potential funding for bundling projects from the community/cooperative level in SWM. iii. Creating a "champion" business model that can serve as a standard example for other municipalities to follow.
3. Incompatible cashflows: Waste management activities have higher operating expenses than capital expenses but current financing sources (e.g., loans and grants) mostly focus on capital financing.	i. Improving municipalities' financial management capacities to align budget sources, such as from state budget, bonds, loans, or waste fee collection, with budget allocation to support the cashflow needs for waste management activities, especially for regular operational expenses. ii. Creating a pool of funds from various sources, including CSR, to better support SWM at the public or community levels with a transparent monitoring and reporting system.

3.3 FUTURE OPPORTUNITIES

To mobilize more financing for organic SWM that is closer to the source of waste and more inclusive (i.e., involving community and informal sectors), the following actions can be implemented:

1. **Designing a holistic approach to waste management.**

   Waste management should not be treated as a separate/isolated sector. Its links to other important areas, such as health, environment, and climate targets, should be considered. Furthermore, decisions to invest in or allocate public budgets for SWM should also consider the economic value of co-benefits such as job creation, budget savings from reduced waste transportation, CO_2, and methane abatement, increased food security as the result of urban farming using fertilizer from waste treatment, or poultry farming using BSF maggots. These co-benefits can provide justification to unlock more types of financing, such as green and sustainability bonds and carbon credits. Linking waste management to education could also raise public awareness of SWM from an early age.

2. **Involving all stakeholders in SWM, including community and informal workers.**

   Waste management cannot be handled solely by the government. However, the government should lead, coordinate, and involve all stakeholders working in the sector, including informal workers and community groups. The government should also design and implement policies that acknowledge and empower marginalized stakeholders, such as waste pickers and community groups, to contribute more to waste management. Since waste collection contributes almost 60% of the direct costs of MSWM (UNEP, 2024), strategies should focus on how to treat waste as close to the source as possible. A roadmap and stakeholder mapping for MSWM help to designate responsibilities among stakeholders. For example:

   a. Mandating methane capture for industries that produce continuous organic waste.

   b. Educating on and mandating waste separation at the community/household levels.

   c. Facilitating and involving public/households/community groups in simple organic waste treatment, such as composting.

d. Implementing extended producer responsibility (EPR) in industry sectors that also cover organic waste.

e. Involving waste picker cooperatives in waste collection and operating waste treatment facilities.

Moreover, the government can clarify its financing strategy through a clear division of responsibilities:

a. **For action in the private sector,** such as methane capture for industrial waste and EPR, private financing from banks or equity is possible since the industries may have established relationships with commercial banks. Thus, public financing may not be required. Government support may be limited to simplifying the permit/regulation of waste treatment projects or offering tax waivers for importing waste treatment technology.

b. **For community business models**, the government can channel state funds or grants from donors or CSR to design campaigns and provide education and technical assistance to increase the awareness and capacity of communities (including on SWM and bookkeeping). It can also provide facilities (including land, if budget allows) to segregate and treat organic waste, especially in the early stages of programs. The government can mobilize funds for these activities from various sources, including multilateral development banks (MDBs), carbon credits, or by issuing green bonds. Governments can also act as buyers—or mediators to buyers—of waste treatment products from community groups, such as organic fertilizer or BSF maggots so that community groups can cover operational expenses or even increase their livelihoods through circular economy practices.

c. **For informal workers,** such as waste pickers, the government can provide technical assistance and opportunities to work in public SWM facilities with competitive payments or contracts.

3. **Creating measurable and transparent indicators to measure and monitor the implementation of waste management.** Any public and private projects should have a monitoring and evaluation (M&E) system with measurable indicators.

   a. For projects using public financing, M&E requires measurable and transparent indicators, including budget allocation and savings, to ensure public accountability.

   b. For projects using donor grants or MDB finance, M&E systems can create trust and attract more financing.

   c. For projects using private financing, financiers would mandate project owners to submit reports of the funding use and fulfill certain indicators. Good M&E will make the reporting and tracking of the indicators easier and more accountable.

4. **Creating legal certainty/status for stakeholders in the waste management sector.** In order to access more rights and financing, SWM entities/business models require legal certainty/status from the government:

a. Community groups require formal legal status, such as that of cooperative or regional-/village-owned enterprises in Indonesia, to obtain land-use rights for SWM from the government. They also need legal status to rent land or sell/supply products from SWM processes. Legal status is also necessary to access finance from banks or other commercial financiers.

b. For workers, legal status as formal workers allows them to access rights such as social/worker insurance and occupational health and safety facilities.

c. Private SWM actors require certainty over policy and permit procedures. Some obstacles for private business models for business-to-business waste collection and treatment in Indonesia include:

    - The double waste management fees that private businesses must sometimes pay: Private businesses, such as hotels, restaurants, and cafés, should pay waste collection fees to municipal governments even if they have contracted a third party for waste collection.

    - Private SWM actors require separate permits to use BSF maggots for waste treatment, as this is considered a farming activity.

    To encourage more private investment in SWM, incentives can be provided, including fiscal (e.g., tax cuts, waste retribution fee waivers) and nonfiscal (e.g., providing a single permit for businesses that cover both organic waste collection and treatment).

d. Across business models, certainty or predictability of cash flows is needed to access commercial/private finance. Financial feasibility is mainly determined by an entity's ability to repay loans to banks/financiers (i.e., cash flow). One common reference for banks when calculating their cash flow is a legal contract that mentions a certain payment to the entity on a regular basis. Such payments can be made by the government or a private entity. The more credible the contractor, the higher the likelihood of getting financing. The contracted payment should cover operational and financial expenses, including loans. To encourage bank financing for any given business model, the government can create a legal contract to cover its expenses. Similarly, SWM entities can seek the same from business-to-business contracts.

APPENDIX

Table A.1: Samples from Bandung, Indonesia

Business sample name	Location	Operator	Activities & technologies
Agro Bintang Nusantara	Bandung City, Indonesia	Private	Waste Collection, Separation, Composting, Recycling
BSF Dago	Bandung City, Indonesia	Community Group	Waste Collection and Home Composting
Jamaras	Bandung City, Indonesia	Community Group	Waste Collection and Home Composting
Neglasari	Bandung City, Indonesia	Government	Waste Collection, Separation, and Composting
Ngadaur	Bandung City, Indonesia	Private	Waste collection, Separation, and Composting
TPST-E Rancabolang	Bandung City, Indonesia	Government	Waste Collection, Separation, and Composting
Waste4Change	Bandung City, Indonesia	Private	Waste Collection, Separation, Composting, and Recycling
RDF	Bandung City, Indonesia	Private	Waste sorting, shredding, drying, and converting waste into fuel for energy production
Small Incinerator	Bandung City, Indonesia	Private	Waste collection, incineration, electricity production, and ash disposal
Large Incinerator	Bandung City, Indonesia	Private	Waste collection, high-temperature incineration, electricity generation, and ash disposal
Sanitary Landfill	Bandung City, Indonesia	Private	Waste disposal, methane capture, and flaring of remaining biogas

Table A.2: Samples from Brazil

Business sample name	Location (municipality/city)	Operator	Activities and technologies
Verdecoop	Entre Rios/Bahia (BA)	Waste picker cooperative	Composting
Copercicla	Santa Cecília do Sul/ Rio Grande do Sul (RS)	Waste picker cooperative	Automated Composting
Minhocaria	Araraquara/São Paulo (SP)	Private	Separate collection and composting of organic household and commercial waste
Ciclo Orgânico	Rio de Janeiro/Rio de Janeiro (RJ)	Private	Separate collection and composting of organic household and commercial waste
Fairs and Sustainable Gardens	São Paulo/São Paulo (SP)	Private-operated, with public ownership (The private operator is chosen through public tender every 2 or 4 years)	Separate collection, composting
Zero Waste Florianópolis (centralized)	Florianópolis/Santa Catarina (SC)	Private-operated, with public ownership (The private operator is chosen through public tender every 2 or 4 years)	Public composting, community composting
Compost Sertão	Sertãozinho/São Paulo (SP)	Community/home composting	Home composting, vermicomposting
Lages Zero Organic Waste Project	Lages/Santa Catarina (SC)	Community/home composting	Home composting, community composting
Zero Waste Florianópolis (HC)	Florianópolis/Santa Catarina (SC)	Community/home composting	Home composting
Biomethanization-AD in Caju Park (PPP)	Rio de Janeiro/Rio de Janeiro (RJ)	PPP	Extra dry anaerobic digestion (methanization), composting of digestate, electricity production, flaring remaining biogas

Table A.3: Co-benefits of organic waste treatment technologies in Bandung samples

Co-benefit category	Co-benefit description	Loseda Composter	Takakura Composter	Bata Terawang	Windrow composting	Biodigester	BSF maggots
Financial	Cost saving on waste collection, disposal, retribution and landfill fees	✓	✓	✓	✓	✓	✓
Financial	Cost savings on chemical fertilizer	✓	✓	✓	✓	✓	✓
Financial	Cost saving for cooking fuel, heating or electricity fuel					✓	
Financial	Revenue from sale of primary products generated by the technology (e.g. compost, biogas, bioslurry, BSF animal feedstock, BSF frass)			✓	✓	✓	✓
Financial	Revenue from sale of secondary products (e.g. organic fruits and vegetables, chicken eggs, chicken, ducks)			✓	✓	✓	✓
Economic	Support for local agriculture through supply of compost	✓	✓	✓	✓	✓	✓
Economic	Improve larger agricultural productivity				✓	✓	
Economic	Development of small-scale businesses related to composting, farming, gardening				✓	✓	✓
Economic	Supporting circular economy by keeping resources within the community	✓	✓	✓			
Economic	Market expansion of primary products (e.g. compost, maggots)				✓		✓
Economic	Employment opportunities to operate the technology				✓	✓	✓
Economic	Job creation in the technology supply chain (e.g. construction, operation, maintenance, agricultural support, BSF nursery)					✓	✓
Social / community	Increased community engagement and awareness about sustainable practices	✓	✓	✓			✓
Social / community	Encourages urban farming for own consumption or for sale	✓	✓	✓			
Social / community	Educational opportunities for schools, local organizations, and local communities on waste management and sustainability	✓	✓	✓	✓	✓	✓
Social / community	Strengthening community bonds through collaborative waste management activities			✓			

Co-benefit category	Co-benefit description	Loseda Composter	Takakura Composter	Bata Terawang	Windrow composting	Biodigester	BSF maggots
Social / community	Reduces reliance on external energy source, promoting energy independence for communities					✔	
Health	Improved (outdoor) air and water quality from reduction in local pollution and odor associated with unmanaged or burned organic waste	✔	✔	✔	✔	✔	✔
Health	Improved indoor air quality, reducing health risks related to respiratory system					✔	
Environmental	Improved soil health and fertility through the use of organic fertilizers (compost, bioslurry, frass)	✔	✔	✔	✔	✔	✔
Environmental	Promotes healthy ecosystem, enhances biodiversity	✔	✔	✔	✔		
Environmental	Captures methane that would otherwise be released into the atmosphere, contributing to climate change mitigation	✔	✔	✔	✔	✔	✔
Environmental	Lowering CO2 emissions from collection/ transportation of waste	✔	✔	✔	✔	✔	✔
Environmental	Lowering CO2 emissions by using alternative fuel					✔	
Environmental	Landfill space conservation	✔	✔	✔	✔	✔	✔

Table A.4: Co-benefits of organic waste treatment technologies in Brazil samples

Co-benefit category	Co-benefit description	Community composting	Vermi composting	Turned piles (windrows)	Passively Aerated windrows	Bio-methanization	MRBT
Financial	Cost savings on waste collection, disposal, retribution and landfill fees	✔	✔	✔	✔	✔	✔
Financial	Cost savings on chemical fertilizer	✔	✔	✔	✔	✔	✔
Financial	Cost saving for cooking fuel, heating or electricity fuel					✔	
Financial	Revenue from sale of primary products generated by the technology (e.g. compost, biogas, bioslurry, BSF animal feedstock, BSF frass)	✔	✔	✔	✔	✔	✔

Co-benefit category	Co-benefit description	Community composting	Vermi composting	Turned piles (windrows)	Passively Aerated windrows	Bio-methanization	MRBT
Financial	Revenue from the sale of secondary products (e.g., organic fruits and vegetables, chicken eggs, chicken, ducks)						
Economic	Support for local agriculture through supply of compost	✓	✓	✓	✓		
Economic	Improve larger agricultural productivity			✓	✓		
Economic	Development of small-scale businesses related to composting, farming, gardening	✓	✓	✓	✓		
Economic	Supporting circular economy by keeping resources within the community						
Economic	Market expansion of primary products (e.g. compost, maggots)						
Economic	Employment opportunities to operate the technology			✓		✓	✓
Economic	Job creation in the technology supply chain (e.g. construction, operation, maintenance, agricultural support, BSF nursery)					✓	✓
Social / community	Increased community engagement and awareness about sustainable practices	✓	✓				
Social / community	Encourages urban farming for own consumption or for sale	✓	✓				
Social / community	Educational opportunities for schools, local organizations, and local communities on waste management and sustainability	✓	✓				
Social / community	Strengthening community bonds through collaborative waste management activities	✓	✓				
Social / community	Reduces reliance on external energy sources, promoting energy independence for communities		✓			✓	
Health	Improved (outdoor) air and water quality from a reduction in local pollution and odor associated with unmanaged or burned organic waste	✓	✓	✓	✓		
Health	Improved indoor air quality, reducing health risks related to respiratory system						
Environmental	Improved soil health and fertility through the use of organic fertilizers (compost, bio-slurry, frass)	✓	✓	✓	✓		✓

Co-benefit category	Co-benefit description	Community composting	Vermi composting	Turned piles (windrows)	Passively Aerated windrows	Bio-methanization	MRBT
Environmental	Promotes healthy ecosystem, enhances biodiversity	✔	✔	✔	✔		
Environmental	Captures methane that would otherwise be released into the atmosphere, contributing to climate change mitigation	✔	✔	✔	✔	✔	✔
Environmental	Lowering CO2 emissions from the collection/ transportation of waste	✔	✔	✔	✔	✔	✔
Environmental	Lowering CO2 emissions by using alternative fuel					✔	
Environmental	Landfill space conservation	✔	✔	✔	✔	✔	✔

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