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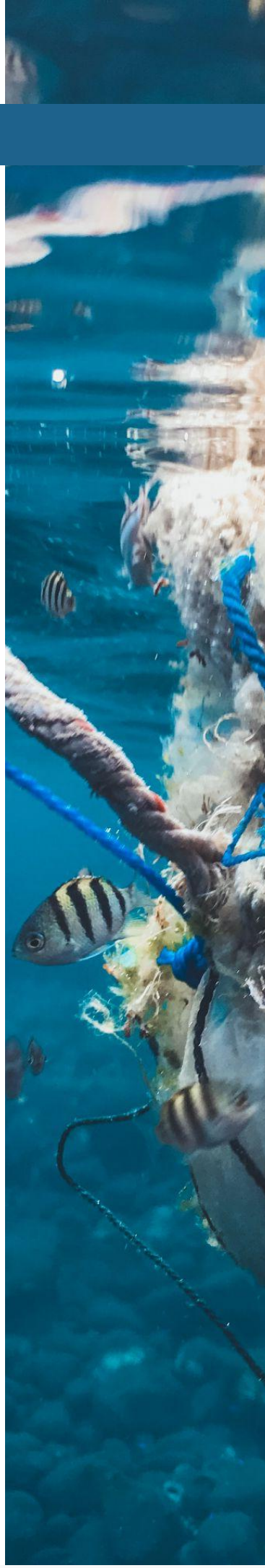
Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Indonesia

The Circulate Initiative

Contents



Glossary

Aggregation / consolidation point	Location at which waste materials are consolidated (bulked) into larger amounts for onward transport. Activities vary by site and may allow for consolidation only or include some pre-processing e.g., sorting or picking of valuable material.
Collected for recycling (CFR)	The CFR rate is calculated using the amount of plastic collected vs. the overall amount of plastic actually recycled. Some plastics that are collected as part of the mixed solid waste are landfilled or sent to WtE. Other plastics collected for recycling may be rejected during sorting or become residues during recycling.
Extended Producer Responsibility (EPR)	A policy approach under which producers are made responsible (either financially or physically) for the end-of-life management of the products and/or packaging they sell.
Formal recyclers	Typically large recycling sites with large-scale equipment that hold suitable business and waste permits and licenses for their operations.
Formal sector	Collective term for municipal (or licensed collectors) and fully permitted/licensed aggregators and recyclers.
Informal recycler	Typically small recycling facilities that operate without full licenses and permits.
Informal sector	Collective term for informal waste workers and typically smaller-scale aggregators and recyclers that operate without full licenses and permits.
Informal waste worker (IWW)	People who earn an income from managing waste but are not formally employed to do so. Roles include collection (including picking), sorting, and other pre-processing and recycling.
Infrastructure (e.g., plastic infrastructure, waste infrastructure)	Equipment and facilities used to aggregate, sort, and/or treat waste materials.
Junk shops	Typically small spaces, often in the houses of the owners. Materials may be brought to the site by local collectors, with owners sometimes also undertaking collection themselves. Usually run informally without licenses or permits.
Municipal solid waste (MSW)	Within this report we use the term 'municipal solid waste' to describe waste generated by smaller sized properties such as households, small businesses, and schools. It generally excludes waste from larger businesses, industrial sites, and from construction.
Municipal waste worker (MWW)	An individual working on behalf of the local government, either employed directly by them or by their (private or semi-private) collection contractor.
Pay-as-you-throw	A policy through which properties are charged based on the amount of waste they present for collection. In some cases, charging for separately presented recyclables is lower than residual waste.
Pemulung	Local term used in Indonesia for informal waste collectors.
Pengepul	Intermediary actors who collect and consolidate waste from Pemulung, selling it on to local Bank Sampahs (Waste Banks) or larger aggregators.
Plastic leakage	Refers to plastic waste that is not kept within managed (formal or informal) systems and 'leaks' into the environment.
Plastic recycling supply chains	A formal or informal system through which discarded plastics can be recycled. Typically includes collection, aggregation, pre-processing, reprocessing, and manufacture into new goods.
Plastic waste	Plastic packaging or products that have been discarded by the user.

Pre-processing	Preparing material for recycling (e.g., can include sorting, label removal, washing, and shredding).
Recyclables	Waste materials collected for recycling.
Recyclate	Material that is recycled e.g., rPET and rHDPE.
Recycling/reprocessing	The process of transforming waste into a new output product so the material can be used again.
Waste/recycling cooperative	While cooperative arrangements can vary, the broad meaning is an umbrella organization with a legal structure that unites individual waste workers and coordinates work undertaken. Cooperatives are usually controlled by workers and provide them with shared benefits and profits.
Waste-to-Energy (WtE)	This mainly includes formal, permitted waste-to-energy plants with heat and electricity recovery, where known. Data sets might also include some basic incineration plants without energy recovery, depending on data sets available.
Waste Transfer Station	Municipal aggregation points that are usually used to transfer waste. They are spread throughout cities to help allow for efficient collection and have no equipment or very basic equipment. They are not designed for waste extraction but are often used by informal waste workers for final extraction before landfill.
Wasteshed	A geographical region having a common solid waste disposal system or designated by the governing institutions as an appropriate area within which to develop a common recycling program.

General abbreviations

CFR	Collected for recycling
EPR	Extended producer responsibility
IWC	Independent waste collectors
KT/yr	Kilo tonnes (or thousand tonnes) per year. Metric tonnes are used.
MSW	Municipal solid waste
MT/yr	Mega tonnes (or million tonnes) per year. Metric tonnes are used.
MWW	Municipal waste worker
T/d	Tonnes per day. Metric tonnes are used.
T/yr	Tonnes per year. Metric tonnes are used.
WtE	Waste-to-Energy

Polymer abbreviations

HDPE	High-density polyethylene
LDPE	Low-density polyethylene
LLDPE	Linear low-density polyethylene
PET	Polyethylene terephthalate
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl chloride
r (e.g., rPET, rPP)	Recycled plastic of that polymer

Introduction

BACKGROUND

Though many urban areas of India, Indonesia, Thailand, and Vietnam have municipally managed waste collection coverage, there remains a high reliance on the informal sector for the collection, aggregation, and recycling of plastic and other valuable materials. The informal sector plays a critical role in the management of material, with workers benefiting directly economically, though this often comes with risks to their health and welfare. Leaving recycling activities to the informal sector results in supply chain insecurity for recyclers and is often a barrier to investment in local plastic supply chain infrastructure. In addition, there tends to be a focus on collecting the most valuable polymers only, leaving large amounts of plastic waste uncollected or leaked into the environment.

The opportunity to improve the management of plastic waste and recover the inherent value is vast in India, Indonesia, Thailand, and Vietnam. There is scope to increase the amount and consistency of recycled plastic supply, preserve the material value within these countries, and reduce dependency on polymer and plastic waste imports. This should concurrently result in an improvement of the welfare of informal workers and the health of communities and the regional environment.

For local plastic supply chains to be effective, several conditions must be in place. These include demand from buyers for recyclates, which needs to be matched by supply of good quality plastic waste; the right regulatory and policy framework and respective implementation measures; and transparent pricing at each stage to incentivize the investment of time and resources. Handling practices at each stage of the plastic recycling supply chain need to be efficient and conducted in a socially- and environmentally-friendly manner. In addition, supply chains must have the ability to scale, to increase the quantity and range of plastic collected for recycling to meet the growing demand for high-quality recycled plastic from local sources rather than imports.

Solutions cannot be achieved by one organization or individual in isolation. Change will require dedication, collaboration, and cohesively planned investment from multiple influencers of local plastic recycling supply chains.

RESEARCH OBJECTIVES

Plastic recycling supply chains are often local and unique as they rely on many informal transactions driven by local conditions, traditions and cultures, as well as local and regional infrastructure and markets. While there are a range of existing studies on national waste flows, few explore the plastic supply chains in more localized contexts. Recognizing this need, The Circulate Initiative, in partnership with Anthesis Group, conducted a detailed assessment of wastesheds in four countries, India, Indonesia, Thailand, and Vietnam.

This document presents the outcomes of this study, which was undertaken in 2022 to map local plastic recycling supply chains and their corresponding infrastructure in selected wastesheds in India, Indonesia, Thailand, and Vietnam.

The objectives were to:

- Understand the supply chains for secondary plastics at a local level, including the key actors, infrastructure, and influencing regulations.
- Understand the economics for secondary plastic at each stage of the local plastic supply chains and the key factors influencing prices.
- Identify where interventions to improve supply chains could be made.

SCOPE AND METHODOLOGY

The study focused on municipal waste (generated primarily by households and small businesses) as this is where many of the local environmental issues are occurring and where there appears to be the most potential to scale up plastic waste collection and recycling.

The wasteshed areas were selected to include:

- The capital city of each country (capital).
- Mega or large cities with existing and functional plastic recycling supply chains e.g., having a number of existing plastics recycling plants (established).
- Cities or regions with considerable plastic waste generation and emerging plastic recycling supply chains e.g., they might have waste collection, but limited sorting and recycling capacity (emerging).

It should be noted that wastesheds broadly reflect the boundaries of the selected cities; however, there is some fluidity. Aggregation and recycling activities sometimes cross boundaries and, where appropriate, relevant infrastructure and key players outside the city boundaries were included in the assessment to provide a better understanding of the wasteshed material flows.

The polymers selected for this study include PET, LDPE, HDPE, and PP. Combined, these are expected to make up around 85% of plastic packaging and food-service plastic. Rigid plastics using PET, HDPE, and PP dominate the post-consumer recycling industry today, whereas flexible packaging using LDPE and some PP or combinations thereof are expected to require further interventions to enter recycling cycles.

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[1] Though both have established basic supply chains, Chon Buri and Rayong were selected in addition to Bangkok in Thailand as it was thought entrepreneurial actions by local supply chain actors made them interesting areas of study.

[2] Da Nang is the name of a region as well as a city. This study only focused on exploring local plastic recycling supply chains in Da Nang city, not the wider region.

Table 1: Cities that were selected for plastic waste supply chain mapping.

	INDIA	INDONESIA	THAILAND	VIETNAM
Capital	Delhi	Greater Jakarta	Bangkok	Hanoi
Established	Mumbai	Surabaya	Chon Buri Rayong[1]	Ho Chi Minh City
Emerging	Chennai	Makassar	-	Da Nang[2]

Information regarding plastic supply chains in each wasteshed was gathered through a review of publicly available literature, as well as interviews conducted with local supply chain actors (59 collectors, 45 aggregators, and 21 recyclers across the four countries). Anthesis Group, the lead research partner for the study, was supported by in-country partners in each country to carry out the local interviews. The in-country partners were Evergreen Labs for Vietnam, PRO India for India, Rebel (with Waste4Change) for Indonesia, and the Stockholm Environment Institute (SEI) for Thailand.

Additional interviews were conducted with organizations privy to local arrangements (such as local plastics associations, municipal waste management organizations, waste operators, and producer responsibility organizations) to gain additional insight and to help corroborate the findings.

The status of plastic recycling in these countries and the nature of informal supply chains means that it is not possible to accurately trace tonnages through the supply chain, to list all active actors, or to undertake a detailed pricing and economic assessment for all wastesheds.

This report provides another step towards understanding wastesheds and relies on primary and secondary information that has been reviewed, analyzed, and extrapolated for this project to provide an informed view for debate and discussion. The data provided should be understood as being the best estimates at this point in time, to be improved on and ratified once waste data monitoring and tracking systems, as part of Extended Producer Responsibility (EPR) and other policy measures, have been implemented. This report focuses on creating a better understanding of the wastesheds and suggests potential interventions to grow plastics recycling and reduce environmental impact.

COUNTRY OVERVIEW[3]

Population

276 MILLION

Total Municipal Solid Waste (MSW) generation

66 MT/YR

Plastic waste generation (in MSW)

6.8 MT/YR

Plastic waste recycled (in MSW)

0.45 MT/YR

Indonesia is the world's largest archipelagic state, consisting of five major islands and about 30 smaller groups of islands. It is the fourth most populated country in the world with almost 60% of inhabitants living in cities.[4] Despite efforts to improve waste management services in Indonesia, it is estimated that only 60% of urban residents have access to waste collection services.[5]

The 7% of plastic waste recycled reflected above is a prudent estimate based on this research, whereas other sources suggest 10% of municipal plastic waste across Indonesia is sent to recycling facilities, with the vast majority of plastics collected for recycling managed through the informal sector.[6] The remainder is landfilled, illegally dumped or burnt. Indonesia has a few smaller formal incineration plants without energy recovery.

Indonesia has strong recycling infrastructure with formal recyclers processing a range of polymers, including PET, HDPE, PP, and LDPE. However, it is unclear how much domestic plastic waste is being recycled. An estimated 220 KT/yr of plastic waste was imported into Indonesia in 2018 which, along with other factors, is impacting the domestic demand for supply of plastic waste for recycling. This is especially challenging as imported plastic waste is perceived to be easier to access, cleaner, and available at scale.[7]

NATIONAL REGULATION

The Indonesian Government set waste management and waste reduction targets in the Presidential Regulation (PerPres) 2017, committing to a 30% reduction at source and (community-based) recycling by 2025.[8] However, progress to date has been slow and plastic waste is growing at 5% per annum.[9]

Indonesia has ambitions to be entirely plastic pollution-free by 2040 with targets in place for waste reduction at source, waste entering the ocean, and waste handling rates to achieve this. The key regulations influencing plastic are outlined in Figure 1. These potentially include a new tax on plastic waste, but no further details have been announced and industry associations have lobbied strongly against the taxation of virgin plastics.

The government aspires to make 100% of materials used recyclable and to achieve 50% recycled content for all plastics, glass, aluminum, and paper/cardboard. To date, no specific funding or implementation mechanisms have been agreed upon, nor has the government stated any explicit enforcement mechanism (e.g., fines or administrative penalties). However, it is understood that the government may publish the names of non-compliant producers.[10]

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[3] Population figure: World Bank – *Data Bank, data for 2021.* MSW generation and plastic waste generation: World Economic Forum - *Radically Reducing Plastic Pollution in Indonesia (2020).* Plastic waste recycled: Calculated by Anthesis Group.

[4] World Bank, Data Bank, data for 2021.

[5] World Bank – *International Bank for Reconstruction and Development: Project Appraisal Document on a Proposed Loan in the Amount of $100 Million to the Republic of Indonesia for a Improvement of Solid Waste Management to Support Regional and Metropolitan Cities (2019).*

[6] Indonesia National Plastic Action Partnership - *Financing System Change to Radically Reduce Plastic Pollution in Indonesia: A Financing Roadmap Developed by the Indonesia National Plastic Action Partnership (2020).*

[7] WEF – *Radically Reducing Plastic Pollution in Indonesia: A Multistakeholder Action Plan (2020).*

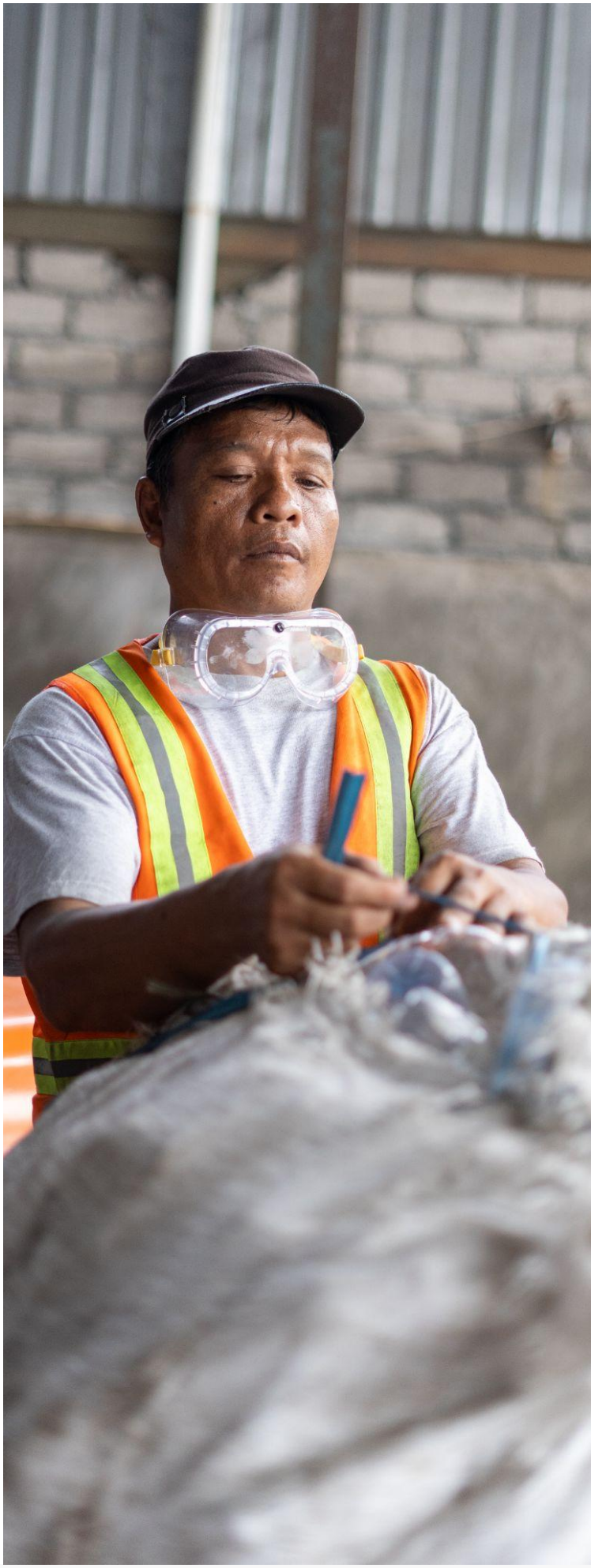
[8] Systemiq – *Producer responsibility in Indonesia: What to know, what stakeholders think, and what could happen next (2021).*

[9] WEF – *Radically Reducing Plastic Pollution in Indonesia: A Multistakeholder Action Plan (2020).*

[10] Ministry of Environment and Forestry, Republic of Indonesia – *National Plastic Waste Reduction Strategic Actions for Indonesia (2020).*

While this is an important step forward in requiring producers generating plastic waste (consumer packaged goods companies, retailers, hotels, restaurants, and cafes) to submit a waste management plan and to report annually on their progress, this is mainly done through self-reporting. The latest government Extended Producer Responsibility (EPR) statement clarifies the responsibilities of producers, complementing established regulations that define the responsibilities in the formal waste system. One key implementation issue is the clear definition of responsibilities between public and private waste management providers and the respective distribution of funding along the supply chain to finance collection, sorting, and recycling of plastic waste.[11]

The current and upcoming regulations have the potential to affect all actors along the plastic waste supply chain; however, effective local implementation and wide-scale enforcement are crucial for success. In addition, a need for a much greater level of monitoring and enforcement, and cohesive working between national and regional agencies has been identified.[12] To date, voluntary EPR action by key companies is driving change in Indonesia as part of a multi-stakeholder approach to implement take-back schemes.



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[11] United Nations Environment Programme – *Plastic Pollution Policy Spotlight: Indonesia (2021).*

[12] United Nations Environment Programme – *Plastic Pollution Policy Spotlight: Indonesia (2021).*

Figure 1: Summary of key national legislation in Indonesia.

Waste Management Act no. 18/2008

2008

Description: The Act establishes that the management of waste is conducted responsibly and sustainably. Local governments oversee the management of waste from households, public/commercial areas and any hazardous waste.

Expected impact: It is expected to boost the formal management of household waste.

Government Regulation No. 81/2012

2012

Description: This regulation states that every person is obliged to reduce and manage the volume of their domestic waste, and this includes the reduction, recycling, and reuse of the waste.

Expected impact: It is expected to lead to price decreases linked to higher availability of valuable plastic waste.

Presidential Regulation No. 97

2017

Description: Serves as a road map for the 2025 Clean-from-Waste Indonesia. The National Strategy Policy includes a 30% reduction of waste production from the source as well as processing 70% of the waste in 2025.

Expected impact: It is expected to lead to price decreases linked to higher availability of valuable plastic waste.

Presidential Decree 35/2018

2018

Description: Relates to acceleration of development of waste-to-energy installation using environmentally-sound technology. Under this decree, the price for electricity purchased by PT PLN (Persero) is prescribed.

Expected impact: Fixed prices may benefit recyclers in case of energy price fluctuations on the global market.

Plastic taxes

2022

Description: As of June 2022, the government is still preparing to charge excise tax on plastic, but there is no information on which plastics would be covered nor a timeframe for implementing plans.

Expected impact: This could lead to potential price increases in the upcoming years.

Indonesia Plan of Action on Marine Plastic Debris

2025

Description: The Plan consists of 5 pillars: behavior change, reducing land-based leakages, reducing sea-based leakages, reducing plastic production and use, enhancing funding mechanisms, policy reforms and law enforcement.

Expected impact: May lead to an increased formalization of the value chain as well as an overall boost of the formal sector through better management of waste.

Status of policy

- Announced
- Being rolled out
- Fully implemented

Stakeholders impacted by policy

- Brands, plastic manufacturers
- Plastic recyclers
- Collection, sorting and aggregation
- Recyclate / R-polymer buyers

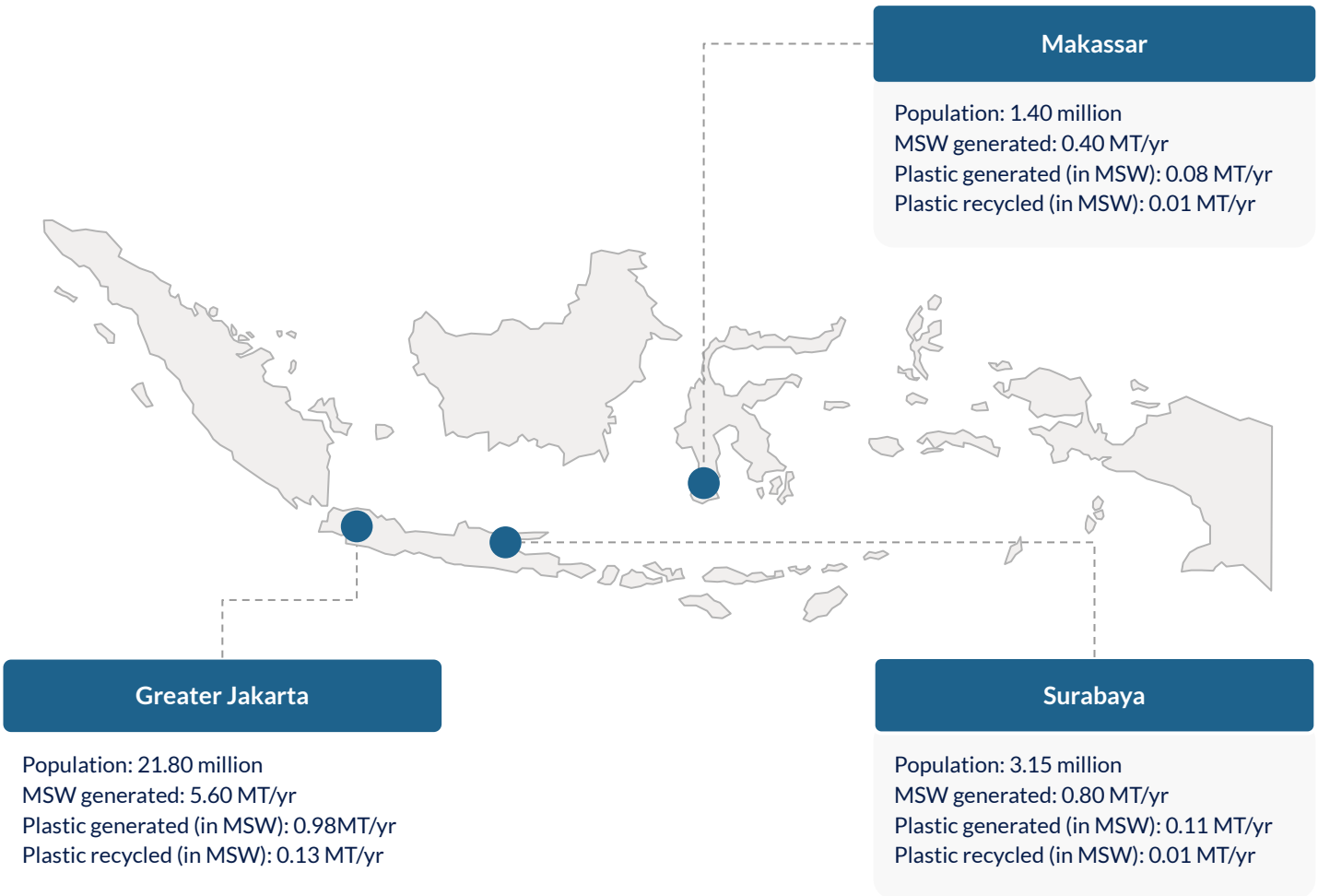
Overview of Selected Wastesheds

The regions selected for plastic waste mapping in Indonesia are:

- **Greater Jakarta:** The capital and largest metropolitan area covering Jakarta, Bogor, Depok, Tangerang, and Bekasi in Indonesia, located on Java, the most highly populated island in the world. Waste is currently sent to a large landfill site, which is near capacity, so waste reduction and recycling are urgently needed to reduce environmental pollution and related issues.
- **Makassar:** Located on the island of Sulawesi, it is the largest city in Eastern Indonesia and the fifth-largest urban center in Indonesia. It is a progressive wasteshed, having piloted the Waste Bank program and digitalization of take-back schemes via Waste Banks or collection points.
- **Surabaya:** The second largest city in Indonesia, located on Java. It is a busy trading port and has experienced recent growth in international industries. There have been a large number of private initiatives in the area to improve waste management.

Within the scope of the World Economic Forum (WEF) 2020 study, Greater Jakarta, Surabaya, and Makassar are considered mega-cities, with populations greater than 1 million and population densities greater than 2,500 people per square kilometer. Mega-cities typically have much higher waste collection rates (74%) than rural and remote areas (16-20%).[14]

Figure 2: Key statistics for the areas selected for plastic waste mapping.[13]



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[13] 2020 population figures from Statistics Indonesia; waste figures based on Anthesis' estimates. Population and waste data referenced are specific to the cities within Greater Jakarta.

[14] WEF – *Radically Reducing Plastic Pollution in Indonesia: A Multistakeholder Action Plan (2020).*

CURRENT SUPPLY CHAINS

The waste system in Indonesia is a dynamic ecosystem with a multitude of actors and facilities providing waste management services at the local, regional, and national levels. This section summarizes how local plastic recycling supply chains typically operate within the selected wastesheds before providing a detailed outline of waste flows, key actors, and infrastructure in the three wastesheds.

Collection: Stakeholders and processes

Formal waste collection officers working on behalf of the local municipality collect household waste using manual pull carts, tricycles (*triseda*) or motorized carts. The mixed waste and recyclables are transported to a small local aggregation facility known as a Temporary Shelter (*Tempat Penampungan Sementara*, or TPS) or to a TPS 3R (material recovery facility) where available.

Informal waste collectors (known as *Pemulung*) collect plastic waste and other recyclables directly from households, as well as via picking from accessible waste containers and littered waste in public places. They interact with the formal waste collection system at all stages, with informal waste pickers present at transfer stations, material sorting and recovery sites, and landfills to remove valuable recyclables from the residual waste stream. Interviews with informal workers indicate that they sort the plastic and prepare it for recycling to improve its value by removing caps and labels from plastic bottles and separating waste into clear and colored plastic before sale to aggregators. *Pengepul* are intermediary actors who collect and consolidate waste from *Pemulung*, selling it on to local *Bank Sampahs* (Waste Banks) or larger aggregators.

In addition to the recyclable plastic waste collected from households by informal waste collectors,[15] households can also sell or deposit recyclables directly at Waste Banks in their neighborhood unit (*Rukun Tetangga* or RT) or community unit (*Rukun Warga* or RW). It is estimated that a Waste Bank typically caters to a neighborhood of 1,000 residents and that in 2019, an estimated 8,000 Waste Banks were operational in Indonesia.[16] [17]

These Waste Banks are semi-formal facilities managed by local communities/neighborhoods.[18] Households that sell recyclables to the Waste Banks have an account through which they can save and withdraw money to recognize the value of the recyclables that they have brought to the Waste Bank as a deposit. Recyclable waste collected at Waste Banks is generally sent to a central Waste Bank (often operated by the local Environment Agency), larger aggregators or directly to recyclers. A payment is made for the waste deposited, which can then be withdrawn when needed after a contribution of 15% is deducted for the Waste Bank's operating costs. Many Waste Banks are supported by the Indonesia Packaging Recovery Organization (IPRO), local community and environmental organizations, and private sector brands. As an example, Unilever is sponsoring 10 Waste Banks throughout Indonesia via its foundation and these are estimated to turn over 1-10 million rupiah in a month.[19] The materials accepted at Waste Banks varies, with some accepting dry recyclables only and some also accepting organic waste.

Each of the wastesheds mapped were identified as having a high leakage rate of 26%, which is due to MSW not being collected from households. This is driven by limitations around current waste management systems and a disconnect between the formal and informal waste collection processes. In addition, Indonesia has a lack of national and regional funding for waste management and a complex administrative landscape in terms of responsibilities for waste services. The distinction between collection and aggregation is fluid in Indonesia as the Waste Banks function as bring banks or collection points for recyclables from households, as well as aggregation points for recyclables from informal waste collectors.

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[15] United Nations Environment Programme – P*lastic Pollution Policy Spotlight: Indonesia (2021).*

[16] Temesi Recycling – *Waste Banks (2022).*

[17] Greeners.co – *Waste Bank in West Jakarta Hit Billions Rupiah of Profit (2019).*

[18] Interviews with local value chain participants, August 2022.

[19] Waste4Change – *Waste Bank to Support Indonesia Clean-from-Waste 2025 (2020).*

Aggregation: Stakeholders and processes

There are different types of facilities that undertake aggregation. These are summarized in Table 1. In some areas, community-based aggregators known as TPS 3R sites support aggregation and sorting of formally collected waste and recycling. High-value plastic (e.g., HDPE and PET) will typically be extracted at these sites and sold for recycling. Although a large number of TPS 3R sites have been built, only an estimated 10-20% are believed to be operational due to a lack of local and regional government funding, issues with residents, and availability of land, as well as operational challenges.[20]

Table 1: Characteristics of TPS, TPS 3R, TPST, and TPA.[21]

Name	Description	Expected characteristics
TPS (Temporary Shelter – *Tempat Penampungan Sementara*)	Waste is transported here before it is moved to either the recycling site, processing site, Integrated Waste Processing Site (TPST), or 3R Waste Management site (TPS 3R).	‣ TPS sites are up to 200 m^2. ‣ Facilities are supposed to classify waste into at least five types of waste (organic, non-organic, paper waste, hazardous waste, and residual waste). ‣ Scheduled collection and transportation activity.
TPS 3R (Reduce, Reuse, Recycle)	TPS 3R sites aim to reduce the quantity and/or improve the characteristics of the waste, which will be further processed at the landfill sites (TPA).	‣ TPS 3R sites are >200 m. ‣ Facilities can include sorting, composting, and/or biogas-producing units, warehouses and buffer zones. ‣ TPS 3R sites should be located as close as possible to the collection service area, or at least within a radius of no more than 1 km.
TPST (Integrated Waste Management Site – *Tempat Pemprosesan Sampah Terpadu*)	The TPST is a place for collecting, sorting, reusing, recycling, processing, and final processing of waste. TPST has a more complex waste processing system compared to TPS 3R.	‣ TPST sites are greater than 20,000 m^2. ‣ Facilities are equipped with a sorting room, waste treatment plant, environmental pollution control, residue handling, and supporting facilities and buffer zones. ‣ Located in the city and/or landfill site. ‣ Minimum distance to the nearest settlement should be >500 m.
TPA (Final Processing Site – *Tempat Pemrosesan Akhir*)	The final process occurs at the TPA, where waste is finally disposed of in landfills.	‣ TPA sites are typically landfills or dumping grounds, which should be fully managed. ‣ Some TPAs are being converted into RDF production and Waste-to-Energy (WtE) facilities to meet the requirement of pre-treatment of waste before landfill.

TPST, sometimes known as integrated waste management sites, are regency-level waste transfer and treatment centers in Indonesia that aggregate both domestic and non-domestic waste. Some sites also produce refuse-derived fuel (RDF) for cement kilns. Valuable plastic waste is sometimes picked from these sites by informal workers if the sites are accessible to them (and permitting arrangements allow it).

Most waste is then transported to a TPA, the final processing site, typically a major landfill site outside city boundaries. Anecdotally, mixed waste is also being dumped illegally as many landfill sites have very little capacity left, which causes environmental pollution and leakage.[22] This also makes enforcement of waste management arrangements complicated and adversely impacts recycling initiatives.

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[20] Information provided by in-country research partner Rebel/Waste4Change *(2022).*

[21] Waste4Change – *Let's Get to Know the Functions of Indonesia's Waste Management Facilities: TPS, TPS 3R, TPST, and TPA (2020).*

[22] Waste4Change – *Indonesia's Waste Emergency: Indonesia's Landfills are on the Verge of Overcapacity (2019).*

Recycling: Stakeholders and processes

There are an estimated 1,300 recycling companies in Indonesia processing plastics[23] and a large number of formal recyclers operate around the three wasteshed areas as shown in Figure 3.

The Indonesian Plastics Recyclers Association (IPR) estimates that there are 120,000 workers at the collector level, 40,000 granulators/grinders, 100,000 plastic factory workers and 60,000 traders in products and recycled materials. 40,000 people in the sectors supporting the plastic industry are also involved in the plastics recycling sector in Indonesia.

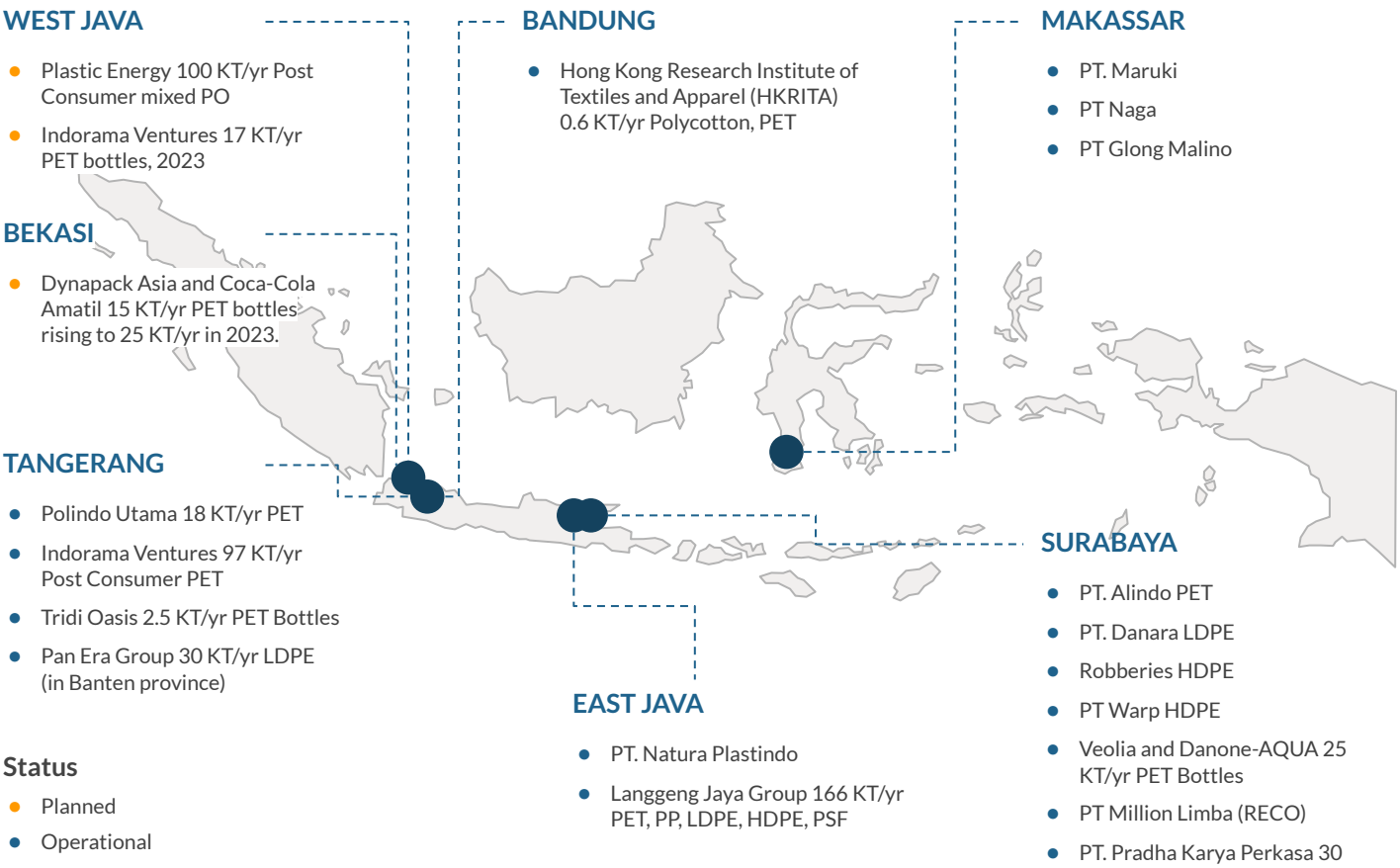
There is considerable demand for PET bottles for recycling in Indonesia. Historically, this has been tied to the polyester yarn industry, although bottle-to-bottle recycling is increasing.

Notably, in 2021, Danone and Veolia launched a recycling facility capable of producing 25 KT/yr of food-grade recycled PET.[24] Although the majority of recycling capability is for PET, there is also some capability for other rigid plastics (HDPE, PP) and flexible plastic e.g., LDPE film bags.

While PET and rigid plastic waste seem to be recycled back into bottles or textiles, the collected plastic films are primarily made into garbage bags and cast buckets for construction.[25]

Supply of plastic waste to recycling facilities is hindered by a lack of waste separation, resulting in large amounts of recyclable waste going to landfills. Survey responses from this study indicate that recyclers are using locally collected material, though high national import tonnages makes it likely that some will be using imported material.

Figure 3: Overview of formal plastic recycling facilities in the vicinity of Greater Jakarta, Makassar and Surabaya that were identified during the mapping research.



[23] Bioplastics News – *Why Ineffective Recycling in Indonesia? (2020).*

[24] Jakarta Post – *Danone-Veolia opens recycling plant to reduce plastic waste (2021).*

[25] Indonesia Plastic Recyclers – *Plastic Bag Waste is Recyclable and Of Economic Value (2019).*

The estimated 0.45 MT/yr of recycled post-consumer domestic plastic waste from MSW only provides a small proportion of the total plastic waste being recycled in Indonesia. Stakeholder interviews suggested that an estimated 0.9-1 MT/yr of PE film is being recycled in Indonesia.; however, this volume is expected to include a mix of plastic film waste from households, industry, and transport. Similarly, an estimated 0.5 MT/yr of rigid PP (including post-industrial waste) and 0.3 MT/yr of PET are assumed to be recycled, with the majority of PET coming from households and small commercial premises. This aligns with the reported 2017 polymer recycling rates of 27% of PET, 18% of other rigids, 12% of flexible mono-materials, and less than 1% of multi-material flexibles being recycled (It is not clear if these figures also include imported plastic waste). Overall, these recycling rates show the discrepancy between recycling and the 50% recycled content targets for these plastic categories set for 2028 by Regulation 75/2019 (Roadmap on reducing plastic pollution by producers).[26]

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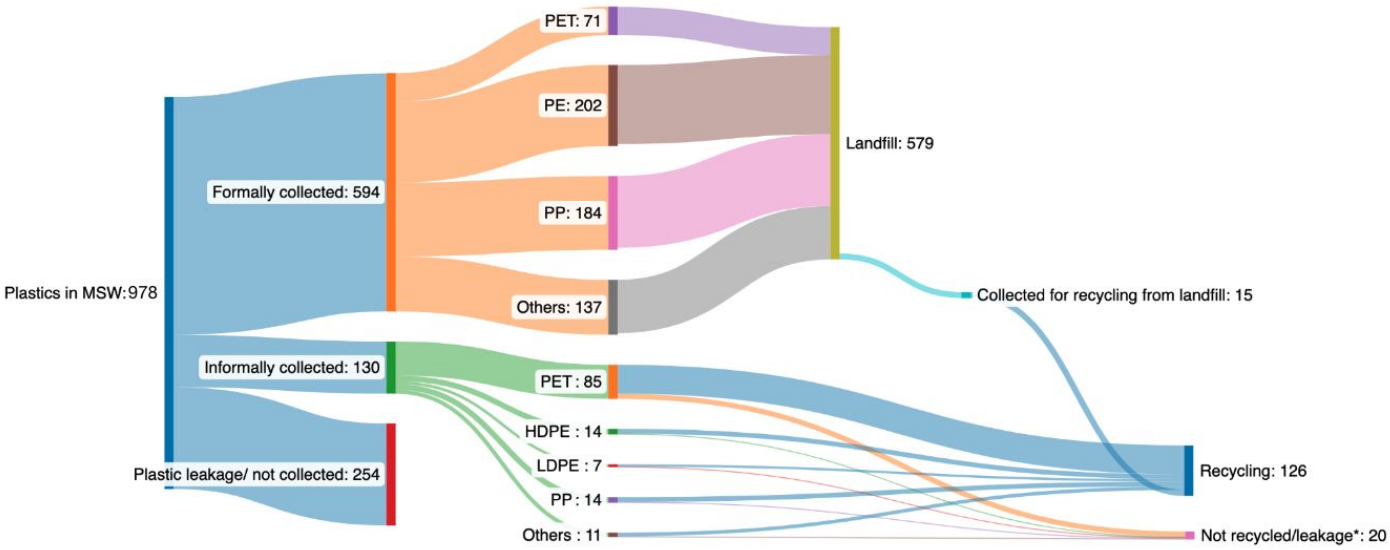
[26] Systemiq – *Producer Responsibility in Indonesia: What to know, what stakeholders think, and what could happen next (2022).*

It is estimated that 17% of plastic collected from municipal solid waste is recycled in Greater Jakarta, equivalent to 126 KT/yr. Nearly all plastic diverted to recycling is being handled through the informal sector, which includes Waste Banks and informal 'door-to-door' collection, as well as picking from landfills. The analysis of waste flows shows some mono-materials and multi-flexible plastics being sent to recycling where there is demand for these waste streams. The plastic waste breakdown is based on national plastic waste composition data from 2020, and responses from the interviews have been used to inform the formally collected polymer waste flows from the informally collected plastic flows.

Figure 4: Flow of plastic within municipal solid waste in Greater Jakarta (thousand tonnes per year).[27 28] Figures are rounded to the nearest whole number and may not sum because of rounding. The data used to calculate the plastic waste flows in Greater Jakarta are based on city data from the National Solid Waste Management Information System (SIPSN) from 2020 or other years. *'Not recycled/leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.



DLH DKI (the Jakarta Environment Agency) regulates and operates waste management in Greater Jakarta, with the local administration of each city — Jakarta, Tangerang, Bekasi, Depok, South Tangerang, and Bogor — managing the collection. The formalized waste collection focuses on ensuring the control of waste and its transportation to landfills to avoid the local environmental issues associated with illegal dumping, open burning, and other polluting waste activities.

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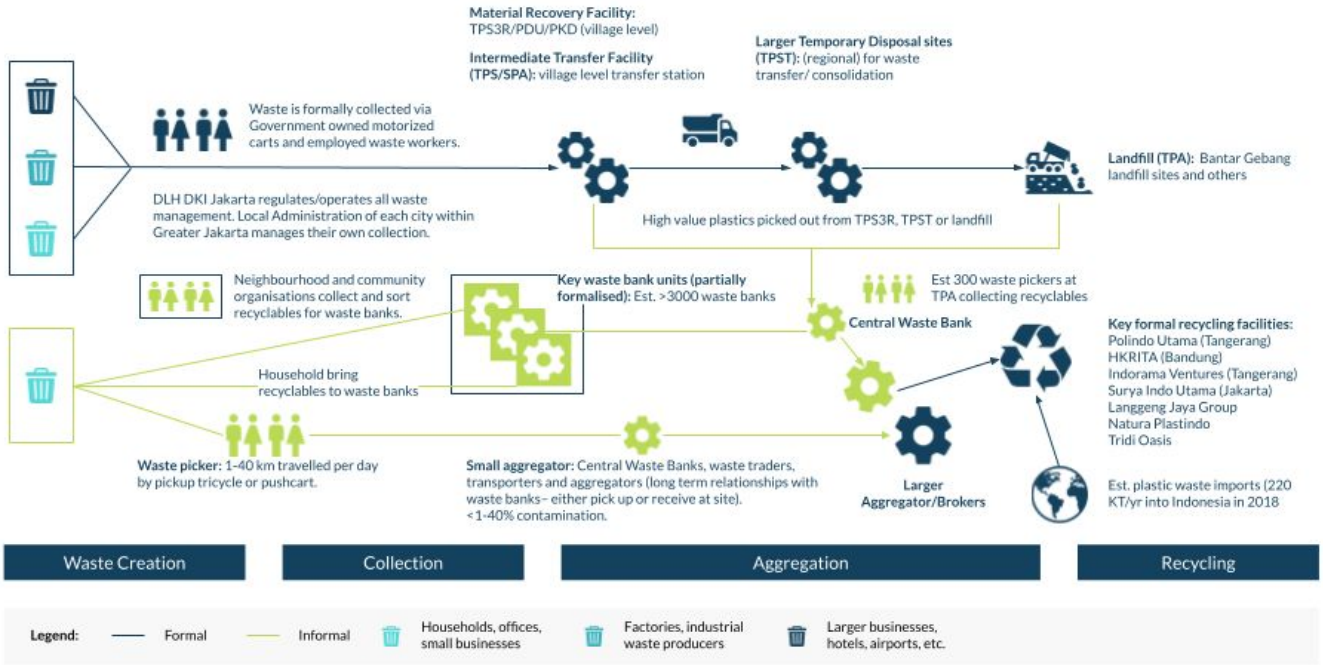
[27] Polymer split of informal collections is based on sample interviews undertaken for this project and might underestimate the amount of PE films being collected.

[28] The data for MSW generation and plastics composition in MSW used to calculate the flows of plastic waste is based on available data from SIPSN, mainly from the year 2020. Data for solid waste generation and plastic composition vary between multiple sources, thus the flows presented are best estimates based on available SIPSN data and interviews. Based on 2020 collection and recycling figures, which do not include the increased funding and support provided via IPRO working with community organizations, Waste Banks and local pickers.

Figure 5: The plastic waste supply chain in Greater Jakarta.



Greater Jakarta is estimated to host over 3,000 Waste Banks, managing 1,000 T/d of recyclables, approximately 12% of Jakarta's total waste, and only 1.5% of the total inorganic waste (plastic and paper). The remainder is either collected by informal collectors as recyclables or formally collected and mainly sent to the TPA and landfill sites.[29] The Waste Bank infrastructure has been traced as follows:

- **Bekasi Regency** has 160 Waste Bank units with a central Waste Bank at the Mekarmukti Recycling Center in Cikarang Utara.[30]
- **Depok Regency** is estimated to have over 500 Waste Banks.
- **Bogor City** is believed to have had 360 Waste Banks in 2019 with a central Waste Bank at the DLHK Bogor City office (1.5 T/day of non-organic waste: plastic, glass, metal, and paper).
- **Tangerang** is believed to have 220 Waste Banks.[31]
- **South Tangerang** had 135 Waste Banks in 2019.
- **South Jakarta** is believed to have 100 Waste Banks. Gesit Induk Garbage Bank in Menteng Pulo is the main Waste Bank.
- **West Jakarta** has one of the largest Waste Banks, Satu Hati Waste Bank, which was established in 2017 and for which, a memorandum of understanding was signed between Bank DNI and Danone. Bank DNI manages the finances of 662 Waste Banks in West Jakarta.[32]
- No information was found for **North and East Jakarta.**

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[29] Ekuatorial – *Waste banks, one of the solutions in waste management (2022).*

[30] Tempo – *Bekasi Regency to Build Central Waste Bank (2021).*

[31] Geo Waste Kota Tangerang – *Cleaning application for the city of Tangerang environment department (2022).*

[32] Greeners.co - *Waste bank in West Jakarta hit billions rupiah of profit (2019).*

In addition, there are TPS-3R sites in each administration; however, only 10-20%[33] of the TPS 3R sites are operational, as shown by the recent 3R Optimization Program run by Dow with Waste4Change in Bogor.[34]

- **Bekasi's** TPS 3R Bina Lindung (2021) can sort paper, plastics, and other materials to reduce landfilling. The Environment Agency is planning to use the *Anggaran Pendapatan dan Belanja Negara* (APBN), or state budget, to build another 11 TPST/TPS 3R units across Bekasi to provide collection, sorting, reuse, recycling, processing, and final processing of waste. The plan is to operate the TPST at sub-district level and the TPS 3R sites at the village level.[35]
- **Bogor** has 29 TPS 3R sites and Dow is supporting the improvement of TPS 3Rs as only 20% of the TPS 3R sites were operational in 2020. Other key facilities in Bogor are:
  - TPS 3R Berseri (Bumi Pertiwi Cilebut).
  - TPS 3R Kahadean (Telaga Kahuripan).
  - TPS 3R Green Altari (Ciomas).
  - TPS 3R Ciparigi 1 and 2[36] and the TPS 3R Waste Processing Site in Paledang.
  - TPS 3R Mutiara Bogor Raya, Katulampa Bogor (1.2 T/day of waste from est. 900 residents), of which 300 kg is inorganic waste of value, which is sold to collectors and aggregators.[37]
- **South Tangerang** has 42 TPS 3R sites, but not all are operational.
- **Tangerang** has eight TPS 3R sites, namely Benua Hijau, Bina Mandiri VTI, ITF Gandasari Jatiuwung, Karsa Mandiri, Nerogtog, Poris Indah (Dongkal), Sapu Pengki Poris Plawad Utara, and Widatama Nusa Jaya.[38]

Each administration also operates their own final disposal sites (TPA or TPS), which process 600-2,000 T/d of waste. Greater Jakarta hosts the following key facilities:

- **Bekasi:** 3,000 T/d TPST Bantar Gebang is the largest plant in Indonesia and provides landfill mining and RDF production (used by Bekasi and Jakarta). This facility was inaugurated in October 2022, but will only be fully operational after January 2023. It is a joint venture of the Provincial Government (*Pemprov*) of DKI Jakarta and the Bekasi City Government (*Pemkot*), the DKI Jakarta and Bekasi Environmental Agencies (LH).
- In addition, Bekasi operates the Burangkeng Waste Final Disposal Site (TPA/TPS 3R) and a landfill site in the Setu District, which operates as TPST at sub-district level and as TPS 3R for villages. A combined 2,000 T/d TPS and WtE facility is planned for Karawang Regency.[40] [41]
- **Bogor:** The 1,800 T/d modern Lulut-Nambo Regional Waste Management and Final Processing Site (TPPAS), which uses mechanical biological treatment (used by Bogor City and Regency, Depok City and South Tangerang City), and TPA Galuga in Bogor, which receives 600-700 T/d of waste.
- **Depok:** The 900 T/d TPA Cipayung, as well as a new 1,800 T/d TPS planned for the West Java province in Bandung, including WtE with a material sorting facility, which is used by Jakarta.

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[33] Information provided by in-country research partner Rebel/Waste4Change.

[34] Waste4Change – *Dow Indonesia and Waste4Change Launch Bogor TPS 3R Optimization Program in 2020 (2020).* Waste4Change – *The 2020-2021 Documentation of the Bogor Regency TPS 3R and Waste Bank Optimization Program (2021).*

[35] Bidik Ekspres – *Bekasi Regency Government will formulate TPST and TPS 3R in every Sub-District and Village (2022).*

[36] List of TPS 3R from Bogor City Environment Agency.

[37] Radar Bogor – *Plastic Waste Problems in Bogor City (2022).*

[38] Geo Waste Kota Tangerang – *Cleaning application for the city of Tangerang environment department (2022).*

[39] Wartakota Live – *Just 82% Completed, Bantar Gebang TPST Has Been Inaugurated By Anies Baswedan, The Largest in Indonesia (2022).*

[40] Waste4Change – *Latest News on Overcapacity Landfills Condition in Indonesia (2020).*

[41] IDBGBF – *Solid Waste Treatment and Final Disposal Management for Bogor Area and Metropolitan Bandung (2017).*

A number of the new facilities were expected to be operational from 2022; however, progress has been slow in implementing contracts, negotiating land replacement agreements for residents, and reaching a financial conclusion, as most facilities require government-backed guarantees. The provision of short-term (annual) contracts vs. the long-term contracts required to provide stability to investors has also been a barrier. It is not clear from the research undertaken which facilities are fully operational to sort plastics for recycling and if these are operating at full capacity.

Bantar Gebang landfill, one of the world's largest landfills, is the main landfill disposal site in Greater Jakarta. However, it is running out of capacity and currently there is a lack of alternative treatment methods for waste. Other landfills in Greater Jakarta include:

- Sumar Batu, Bukareng and Sumurbatu in **Bekasi**.
- Sarimukti landfill in **Bandung**.
- Nambo landfill in **Bogor**.
- Cipeucang landfill in **South Tangerang**.
- Jatiwaringin open dumping/landfill in **Tangerang** (2,000 T/d).

Construction of five new WtE plants is planned, but progress has been slow and it is anticipated that the first 660 KT/yr (2,200 T/d) plant will begin construction at the end of 2022.[42] The plant will be operated by city-owned developer Jakpro, a consortium of the state-owned construction firm Wijaya Karya (Wika) and waste management company Indoplas Group.

The research identified some key formal recyclers of PET and other rigid plastic waste in the area, including Indorama and PT Polindo in Tangerang. PT Polindo has a memorandum of understanding with some of the larger domestic aggregators to ensure consistent PET feedstock supply. The aggregators receive a payment in return for an exclusive commitment to Polindo. Polindo determines the buying price, which trickles down to influence prices paid to smaller aggregators and collectors, but also impacts pricing transparency.[43] It is not known if other facilities rely on domestic supply or imported plastic waste.

Greater Jakarta is a key area for private sector initiatives aiming to improve recycling and waste management. For example, P&G has recently worked with Octopus[44] and the DKI Jakarta Environment Agency to launch the 'Conscious Living' program, through which the public can use an app to report the types of material they want to deposit, which are then collected from households. The project aims to provide a solution for plastic sachet waste, multilayer plastic, and HDPE by diverting it away from landfills to create refuse derived fuel.[45] Coca-Cola has also undertaken a number of initiatives in Jakarta (and wider Indonesia), including the development of digital solutions to increase collection rates, investing in reprocessing infrastructure, and incentivizing take-back of PET bottles.[46]

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[42] Tempo – *ITF Sunter to Generate Electricity up to 35 MWh: Jakpro (2022).*

[43] Information provided to Anthesis Group by in-country partner Rebel based on research undertaken in 2022.

[44] More details on Octopus are provided in the Makassar wasteshed review.

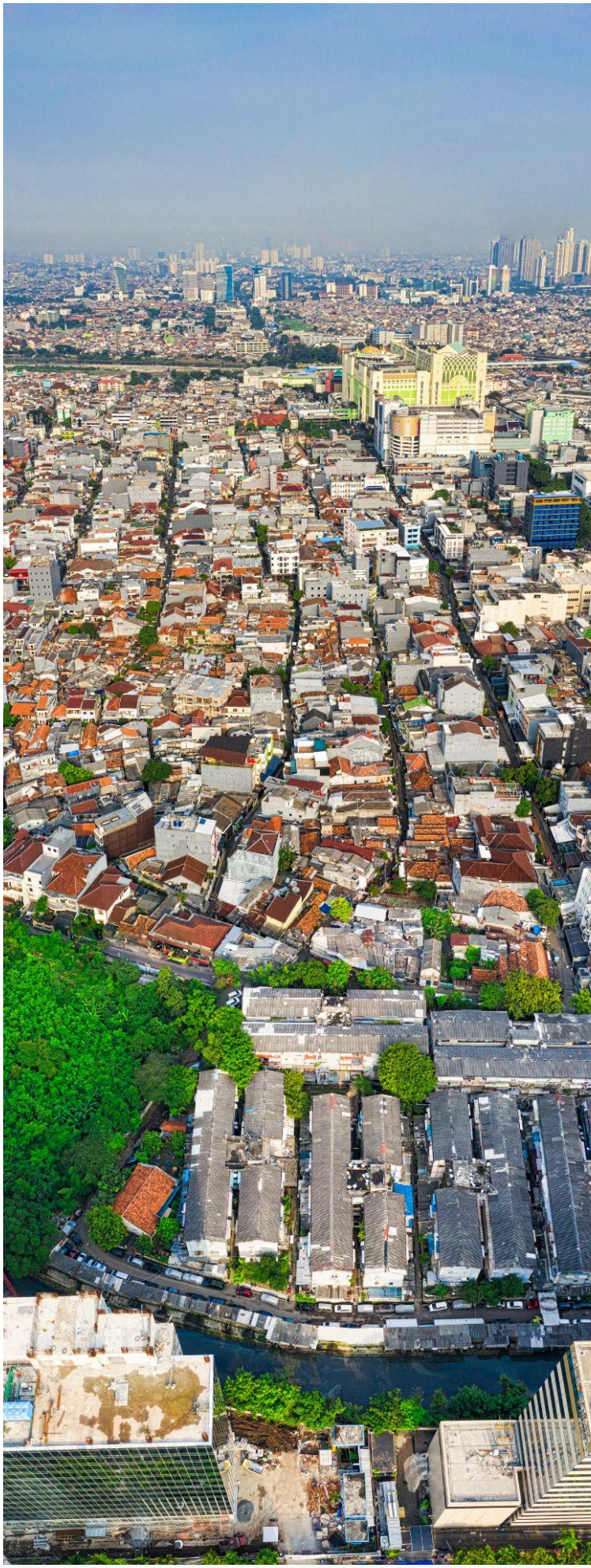
[45] Petikine – *P&G Indonesia and Octopus Expand The Concept of Conscious Living to Jakarta (2022).*

[46] Jakarta Globe – *Coca-Cola Indonesia on the Journey to A World Without Waste (2022).*

The wasteshed level analysis can only provide an initial insight into the plastic waste supply chains in Greater Jakarta and its cities and regencies. This is due to the limited data that is publicly available, as well as the limitations on the number of surveys that could be conducted with local stakeholders within the scope of this research. Based on primary and secondary research, Tangerang and Bogor seem to be most active in creating a more circular waste management infrastructure, followed by Bekasi and Depok, which are also actively trying to reduce the landfilling and dumping of waste.

The Greater Jakarta wasteshed has seen considerable growth in Waste Banks accepting and sorting recyclables, which are supported by private and voluntary organizations, as well as the regency governments. The research has shown that a number of small- and large-scale waste management projects are piloted using a multi-stakeholder approach involving governments, consultancies, and non-governmental organizations (NGOs), as well as technical implementation partners.

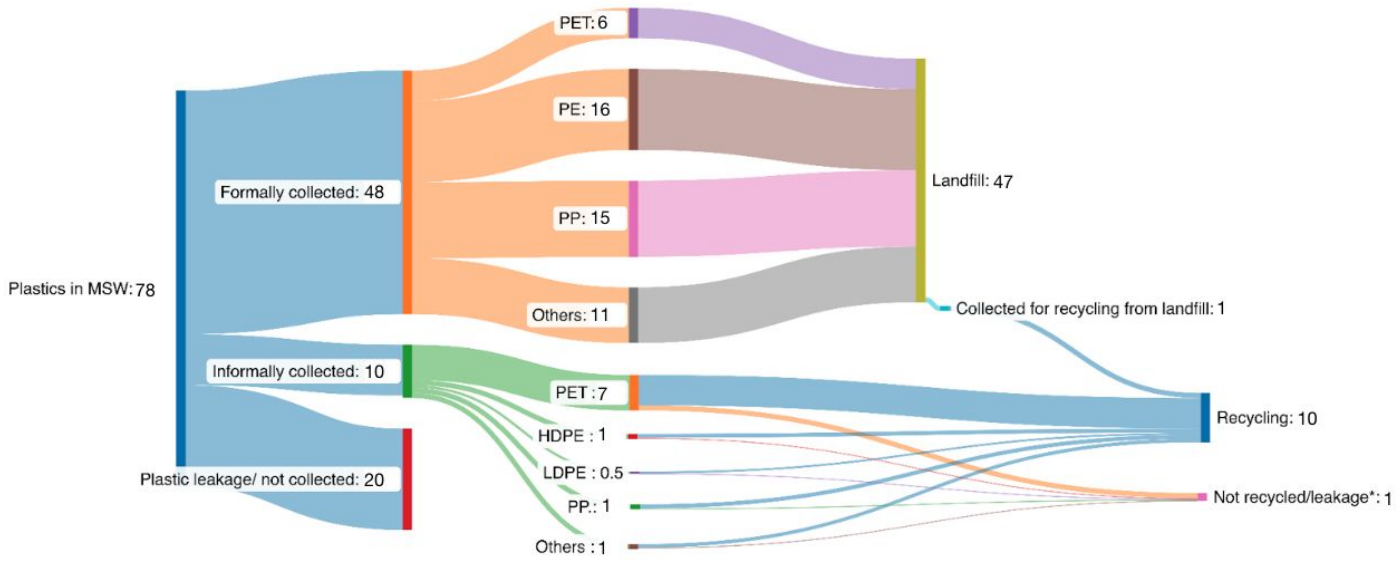
However, the identified recycling capacity in the wasteshed (an estimated 162.5 KT/ yr of operational and planned capacity based on Figure 3) is much larger than the anticipated recycled tonnage traced in the waste flows. The discrepancy is due to a combination of limited availability of waste data, recyclers processing post-industrial and imported plastic waste, as well as individual processors setting up parallel collection schemes at locations like hospitality venues and transport hubs.



Insights on local plastic recycling supply chains in Makassar

In Makassar, it is estimated that 17% or 10 KT/yr of plastic waste collected in the MSW is being recycled annually. An estimated 74% of plastic waste is collected via formal MSW collection. The majority of formally collected plastic waste is sent to landfills (98%), with 2% collected by the informal sector from landfill sites. The polymer breakdown is based on national 2020 plastic waste composition data and responses from the interviews have been used to inform the polymer waste flows from the informal plastic waste flows.

Figure 6: Flow of plastic within municipal solid waste in Makassar (thousand tonnes per year).[47] [48] Figures are rounded to the nearest whole number and may not sum because of rounding. *'Not recycled/leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.



The City Government of Makassar regulates and operates all waste management in the city, but the local administrations manage their own collections. Waste is formally collected via government-owned motorized carts and employed waste workers. It is then sent to a TPS where waste is stored before being disposed of or sent to a material recovery facility (TPS 3R) or a recycling center, locally known as *Pusat Daur Ulang* (PDU) where sorting, and sometimes recycling, is carried out at a community level. Larger temporary disposal sites (TPST) at the regional level handle waste transfers and consolidation.

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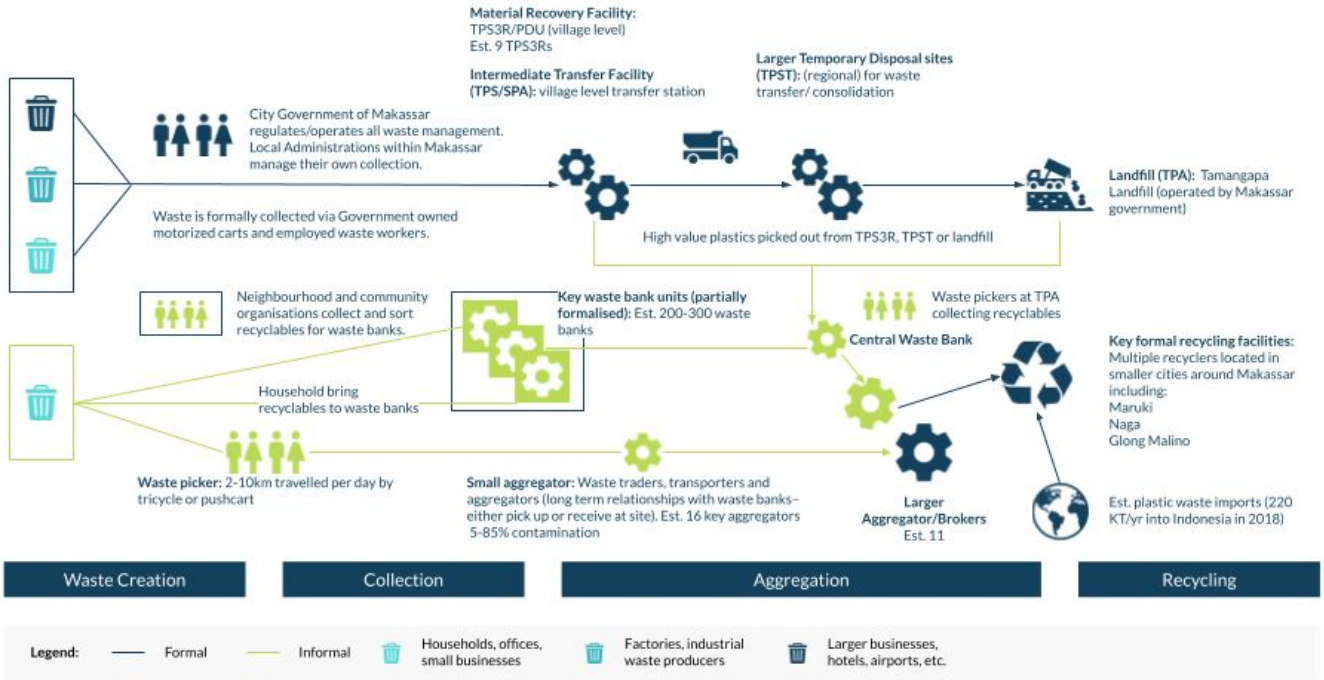
[47] Polymer split of informal collections is based on sample interviews undertaken for this project and might underestimate the amount of PE films being collected.

[48] The data for MSW generation and plastics composition in MSW used to calculate the flows of plastic waste is based on available data from SIPSN, mainly from the year 2020. Data for solid waste generation and plastic composition vary between multiple sources, thus the flows presented are best estimates based on available SIPSN data and interviews. Based on 2020 collection and recycling figures, which do not include the increased funding and support provided via IPRO working with community organizations, Waste Banks and local pickers.

Figure 7: The plastic waste supply chain in Makassar.



It is estimated that there are 200-300 Waste Bank units in Makassar, which are part of the Makassar Waste Bank program. One example is the Bank Sampah Euphorbia, which processes 0.75 T/month of waste. Waste is brought in from households, and neighborhood and community organizations also collect and sort recyclables for Waste Banks. Makassar has a central Waste Bank, where all the waste collected from the Waste Bank points is collated. This is operated by the Makassar Environmental Agency, which will then buy the waste from the Waste Bank units before selling the plastics to a private aggregator (or 'vendor').

In addition, waste pickers are integral to the supply chain in Makassar. Informal aggregators source recyclables from informal waste collectors, who sell to larger aggregators, which compress and bale plastic before it goes to recycling facilities. The NGO, Yayasan Peduli Negeri, supports these informal collectors and encourages them to use Unilever's collection points for multi-layer plastics (an estimated 10 million collected points in Indonesia).

The Makassar Green and Clean (MGC) program is supported by Unilever Indonesia, the Makassar City Government and the Yayasan Peduli Negeri Foundation. It was originally launched in 2008 and then relaunched in 2022 to support the segregation and sorting of waste at Waste Banks in Makassar.

In order to improve transparency of Waste Banks, the Municipal Government of Makassar has signed a memorandum of understanding with PT Daur Ulang Industri Terpadu to develop a digital system to connect producers of plastic waste with waste collectors and recyclers. The waste distribution app, 'Octopus' standardizes the types, condition, and weight of non-organic waste and provides an IT-based, transparent, and accountable Waste Bank management system. The program also includes Makassar's 1,000 registered and verified informal waste pickers, which are part of the Yayasan Peduli Pemulung ('Care for Scavengers Foundation').

Formally collected municipal waste is mainly transported to the Tamangapa landfill outside the city where informal collectors pick recyclables from the landfill site. TPA Tamangapa is the only landfill disposal site in Makassar receiving an estimated 700 T/d of waste. TPS and TPS 3R sites receiving materials prior to being sent to landfill include:

- TPS 3R Tanjung Lestari in Makassar city.
- TPS 3R Darul Aman Unggul Mandiri in Makassar city.
- TPS 3R Panciro and Samata in Gowa.

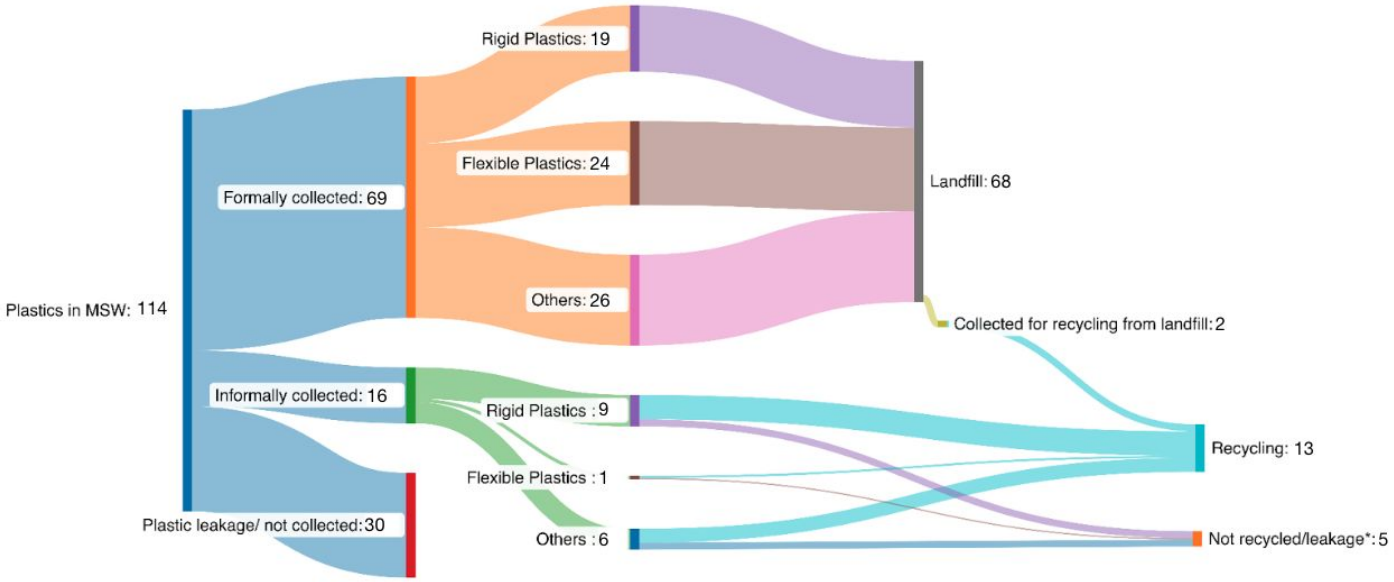
In Makassar, some key recyclers are located near the Kima Industrial Plant: PT. Maruki, PT. Naga, PT. Glong Malino. Others are active in Ambon (Maluku) and collaborate with recyclers from Makassar by combining their plastic flakes or granules to ensure sufficient volumes for export. PT. Milion Limbah Indonesia converts jerry cans and other blow-molded plastic to recycled pellets, with plans to increase capacity to 3,000 T/yr before 2024.

Makassar is one of the major waste producers in Eastern Indonesia and is delivering the Waste Bank system in cooperation with private industry and informal workers' associations in a multi-stakeholder approach, which is supporting the recycling industry and export of recycled plastic, anecdotally. The introduction of the digital system to connect Waste Banks and recyclers is another stepping stone to create a more transparent market and enable product take-back schemes. However, recycling overall is still low as the majority of plastic is being formally collected for transfer to landfills with very limited sorting and extraction.

Insights on local plastic recycling supply chains in Surabaya

Recycling rates for plastic collected from MSW are slightly lower in Surabaya than in Makassar and Greater Jakarta, estimated at 15% or 13 KT/yr. Almost all the plastics recycled in Surabaya are due to the collection efforts of informal waste pickers. Approximately 80% of plastic is collected by the formal sector, but the majority of this is disposed of in landfills. The polymer breakdown is based on Surabaya plastic waste composition data from 2020 and responses from the interviews have been used to inform the polymer waste flows from the informal plastic flows.

Figure 8: Flow of plastic within municipal solid waste in Surabaya (thousand tonnes per year).[49 50] Figures are rounded to the nearest whole number and may not sum because of rounding. *'Not recycled/leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.



The Surabaya Municipal Government regulates waste management in Surabaya – the Green Spaces and Cleansing Agency (DKRTH) operates and transports solid waste from transfer stations to landfills and manages material recovery facilities.

The collection of MSW has been supported by many local waste management initiatives led by community organizations on a sub-district level (locally known as the RT/RW[51]). There have been significant developments in community waste management and local waste infrastructure over the past two decades and, in comparison to many other areas in Indonesia, Surabaya has been developing strong and innovative systems for managing waste.[52] For example, the public can make fare payments for city buses using plastic bottles with a reported 16,000 'plastic passengers' per week.[53]

There are over 200 Waste Banks in the region. The region also has a centralized 'Master' Bank, which is part of the Waste Community Accelerator program that works with Griya Luhu, a digital Waste Bank platform provider based in Bali.[54]

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[49] Polymer split of informal collections is based on sample interviews undertaken for this project and might underestimate the amount of PE films being collected.

[50] The data for MSW generation and plastics composition in MSW used to calculate the flows of plastic waste is based on available data from SIPSN, mainly from the year 2020. Data for solid waste generation and plastic composition vary between multiple sources, thus the flows presented are best estimates based on available SIPSN data and interviews. Based on 2020 collection and recycling figures, which do not include the increased funding and support provided via IPRO working with community organizations, Waste Banks and local pickers.

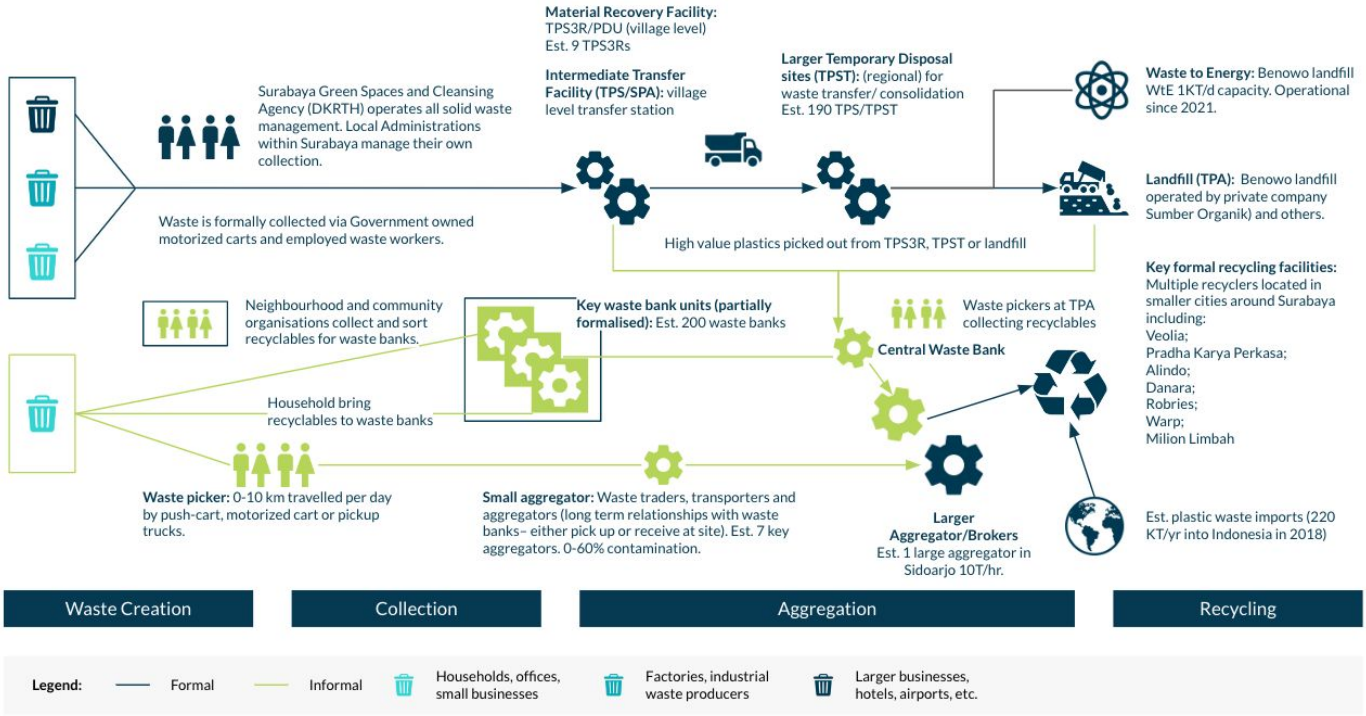
[51] RT stands for *Rukun Tetangga* or Neighbourhood Unit, while RW stands for *Rukun Warga* or Community Unit.

[52] United Nations – *Closing the Loop on Plastic Waste in South East Asia: Surabaya City Profile (2020).*

[53] United Nations – *Closing the Loop on Plastic Waste in South East Asia: Surabaya City Profile (2020).*

[54] Ocean Plastic Prevention Accelerator (OPPA) – *Waste Community Accelerator (2022).*

Figure 9: The plastic waste supply chain in Surabaya.



Of the estimated 190 TPS sites in Surabaya, nine are TPS 3Rs located in Karang Pilang, Kedung Cowek, Sutorejo, Tenggilis Mejoyo, Gunung Anyar, Waru Gunung, Jambangan, Bratang and Osowilangun.[55] TPS Superdepo Sutorejo is a waste sorting facility that was opened in 2013 as a cooperation between Surabaya City Government and Kitakyushu City, Japan. The facility receives 25 T/d of household waste and can process 12-15 T/d. Waste is separated and residual waste is sent to Benowo landfill.[56] There is no further information regarding the operational status of the other facilities.

The key final disposal sites (TPA) in Surabaya include:

- TPA Benowo: Processing 1200 T/d, it is the largest and main landfill site in Surabaya. Recently opened on the landfill site, Benowo PLTSa is Indonesia's first and largest WtE plant, operated by the Surabaya City Government and PT. Sumber Organik and processing 1,000 T/d.[57]
- TPA Ngipik in Gresik: 165 T/d entering the landfills in 2020.[58]
- TPA Pusat Daur Ulang Jambangan: 6 T/d separating plastic waste from organics, residual waste is picked up by collectors to be sent to Benowo landfill.[59]

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[55] Repjogja – *Nine TPS in Surabaya Have Implemented the 3R Concept (2021).*

[56] Jawa Pos – *Super Depo Sutorejo, the Real Form of Cooperation between Surabaya and Kitakyushu (2022).*

[57] Kompass – *Benowo PLTSa Technology, Illuminates Surabaya City While Solving Waste Problems (2022).*

[58] Radar Gresik – *Since 2016, TPA Ngipik Overload (2021).*

[59] Tunas Hijau – *Garbage Recycling Center Processing 5-6 Tons of Garbage Every Day (2019).*

There are multiple recyclers in the smaller cities around Surabaya (Pasuruan, Probolinggo, Gresik and Mojokerto). These include PT. Alindo, PT. Danara, Robries, PT. Warp, PT. Milion Limbah (RECO), PT. Pradha Karya Perkasa, and Veolia. Aggregators supply material to different recyclers, depending on the polymer. PT. Pradha Karya Perkasa is a recycler with a processing capacity of 30 KT/yr of plastic that accepts mixed input, including mixed rigid plastics, such as HDPE, LDPE, PP, and PET. A relatively new site for PET recycling is a joint initiative between Danone's Aqua brand and Veolia, which has the capacity to produce 25 KT/yr of food-grade recycled PET.[60] Danone's Aqua brand supplies 40% of Indonesia's bottled water market,[61] and has partnered with Veolia to help secure a supply of recycled content PET for its bottles.

Surabaya has a well-established network of Waste Banks, TPS 3R, and TPA sites, as well as the first WtE plant in Indonesia. In early 2019, the city was awarded Adipura Kencana, the highest clean city award, to recognize the city's progress.[62] However, despite the available infrastructure, the recycling rates for plastic are low, which suggests that sorting of plastics for recycling predominantly still takes place at Waste Banks and via informal collection/waste picking on a limited scale.

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[60] Jakarta Post – *Danone-Veolia opens recycling plant to reduce plastic waste (2021).*

[61] Circulate Capital – *Investing to Reduce Plastic Pollution in South & Southeast Asia: A Handbook for Action (2019).*

[62] Pace Circular - *A Financing Roadmap Developed by the Indonesia National Plastic Action Partnership (2020).*

Analysis of pricing and pricing transparency along the value chain[63]

The amounts and types of plastic waste collected for recycling are dependent on the value of the polymer at different stages of the value chain and the level of pricing transparency.

Pricing transparency refers to the degree to which pricing information is available to all buyers and sellers in a market. High levels of pricing transparency ensure healthy competition, efficient markets, and better pricing of products and is often considered an indicator of an efficiently operating supply chain, which enables growth.

Data collected through interviews in Indonesia highlights the lack of consistency in the price points in some of the polymer markets, which can be expected by collectors selling plastic waste, aggregators buying plastic waste, and recyclers buying feedstock for recycling. The range in data could be due to the processes used, material quality or regional differences, but is also highly likely to be influenced by the lack of transparency inherent in the market. Overall, there is little transparency across the country and the role of aggregators seems to be more limited – not necessarily fitting with the value chain price points collated.

This might be due to the role of Waste Banks in Indonesia, which have a collection and aggregation role, and set prices according to the supply of recyclables and the demand from small and large aggregators serving the plastic recycling sector. In particular, this occurs in areas where central or master Waste Banks are operated by the respective administrations or environment agency. These public sector organizations respond slowly to changes in market prices set by larger aggregators and often only update buying prices monthly to reduce the pricing fluctuations (in essence, to stabilize the prices). Pricing varies from one Waste Bank unit to another, especially where no central Waste Banks exist to stabilize prices. Publication of prices on a weekly basis at a regional or national level could contribute to better pricing transparency, as well as more granular pricing in relation to quality levels.

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[63] The findings presented in this section of the report are an extract from a pricing and policy interventions analysis on the recycled plastics value chain that was undertaken by The Circulate Initiative in parallel to this study. The results are published separately from this report.

Figure 10: Indonesia PET pricing information from research and stakeholder interviews.

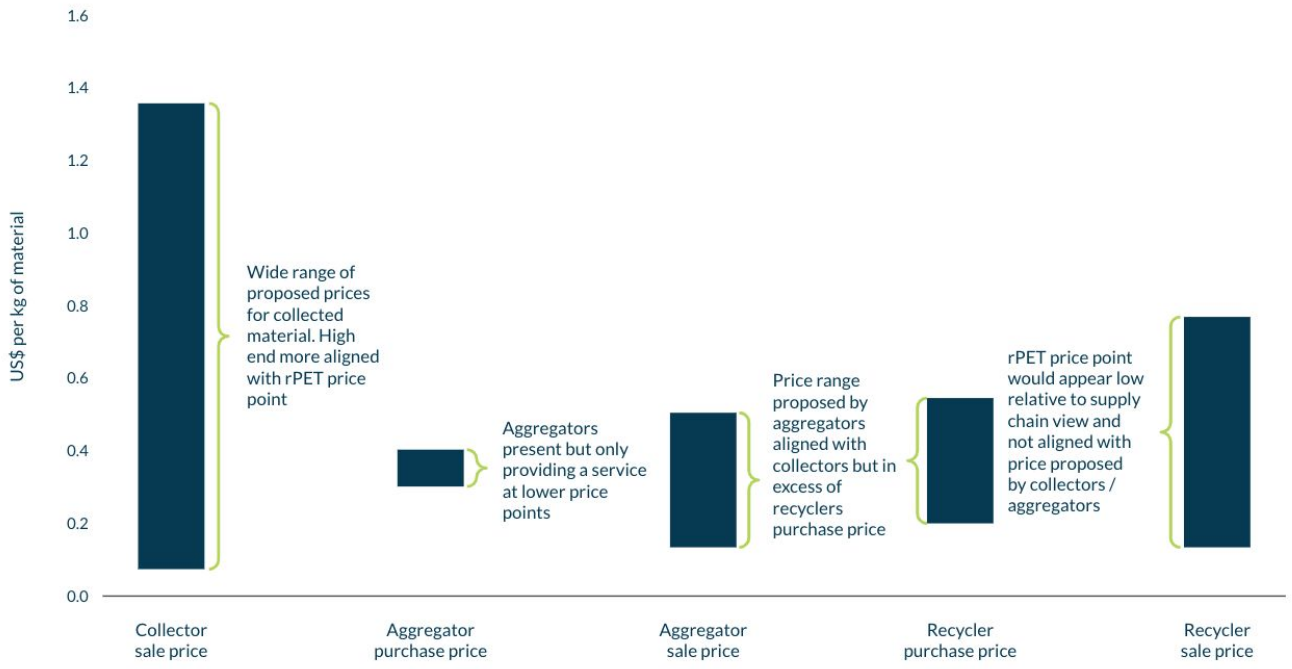


Figure 11: Indonesia HDPE pricing information from research and stakeholder interviews.

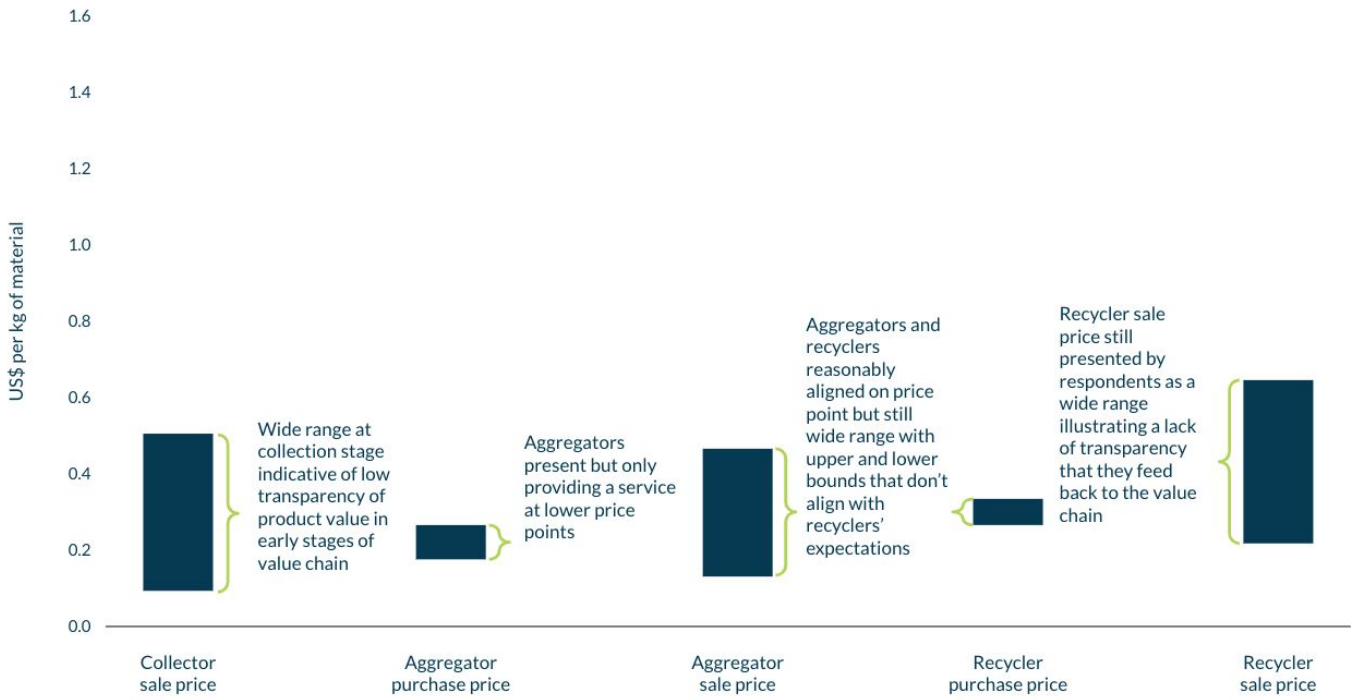


Figure 12: Indonesia PP pricing information from research and stakeholder interviews.

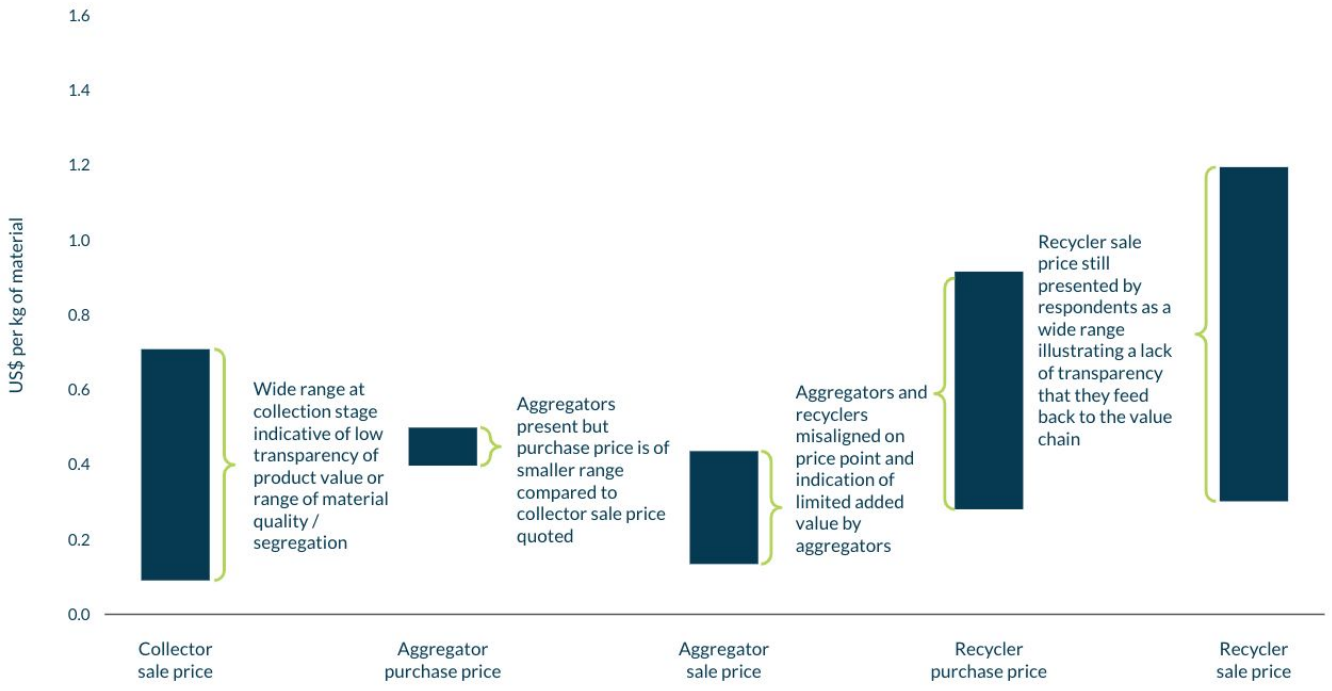
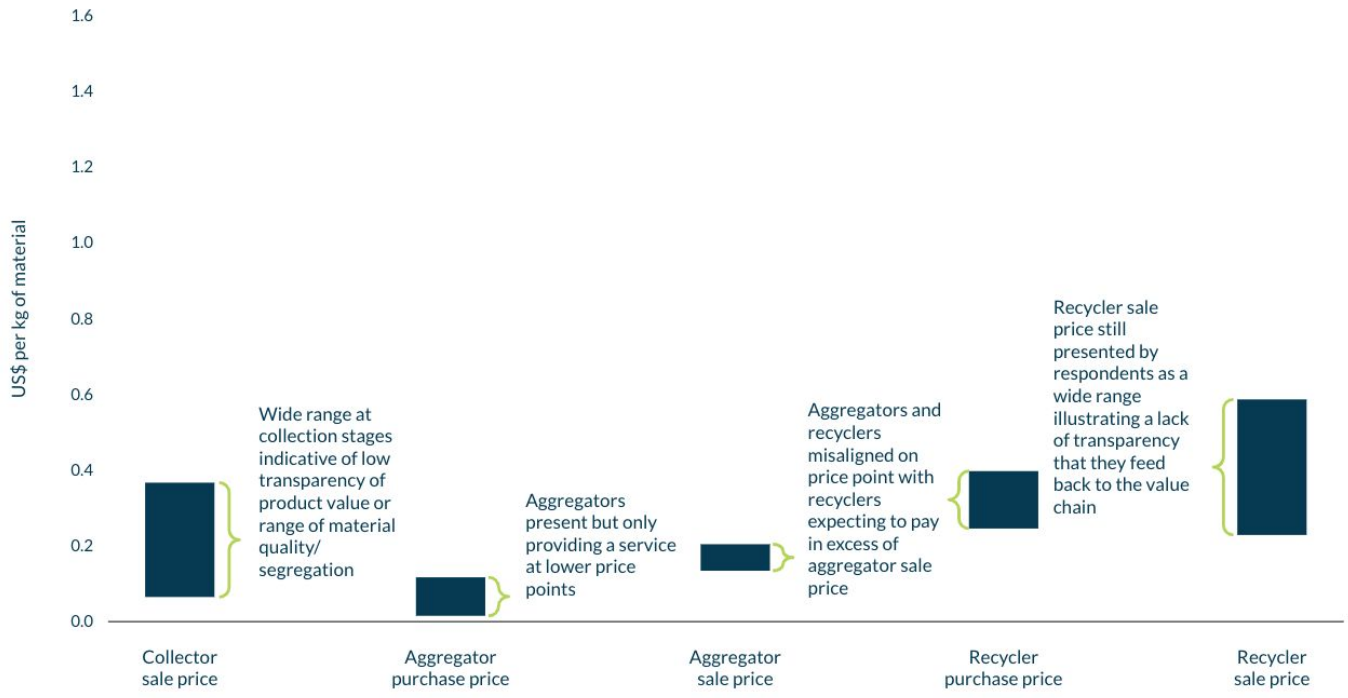


Figure 13: Indonesia LDPE pricing information from research and stakeholder interviews.



In addition, the variation in data collected through interviews in Indonesia highlights potential inconsistencies across the value chain. This is evident in the early stages of the value chain with aggregators' purchase price points often being far lower than the price points provided by collectors. This could be a result of aggregators' more limited involvement in the value chain operating only with lower-value material, or it could be that they are accessing waste from more informal collectors on lower wages. The higher-end collector prices are likely to represent more formalized waste collectors and central Waste Banks with a more direct route to recyclers and a better understanding of the value of their plastic. The wide range of price points presented particularly by collectors and recyclers also presents an issue for transparency, indicating multiple business models at each value chain step, or a lack of consistency in pricing data caused by limited transparency.

The plastic waste supply chains in Indonesia indicate an imbalance in market power, which is mostly benefitting recyclers in the supply chain and negatively impacting collectors and aggregators. Analysis of supply chain actor profit margins (as a proxy for market power) drawn from the survey data estimates that 70-80% of the total trade benefits in the value chain is attributable to the recyclers, while the remainder is split between aggregators and collectors. It is also evident that a large proportion of market power is retained by recyclers, and this is comparable to other geographies reviewed. In Indonesia, the share of trade benefits from the value chain not retained by recyclers is skewed more towards collectors, with limited value added by aggregators, who take a lower proportion of the revenue.

This means that in practice, any price increases associated with the final output products will not easily flow back to the earlier stages of the value chain, such as collectors. However, a more direct link between recyclers and collectors may influence the high upper range of price points presented by collectors in Indonesia as they have greater knowledge of the value of the end product. This impacts the amounts, formats, and polymers being collected in the supply chain.

In principle, virgin and recycled PET, HDPE, PP, and LDPE are commodities that are traded in well understood markets, where values are influenced by virgin polymer prices and recyclate quality that should filter back into supply chains. However, the plastic waste value chain in Indonesia seems to challenge this with a stronger connection between collector sale prices and recycler purchase prices, indicating the lesser role of aggregators in the value chain. In the case of PET and LDPE markets, the sale price of recyclers seems to be lower than might be anticipated to support and sustain the processing costs associated with collection, sorting, and aggregation activities within the value chain.

The comparison between estimated recycling rates and value yields (value of recycled plastics using recycled pricing vs. value of plastics collected using virgin prices) has only been available for recycled PET and PP in Greater Jakarta and Makassar.[64] Analysis shows that recycling performance for PET in both regions is comparable at 50%, whereas PP is 7% of collected plastics. While the recycling performance is strong for PET, the performances of PP and other plastics are much weaker. This low price point of output materials is demonstrated by the low value yields, with less than 50% of the value of virgin plastic retained.

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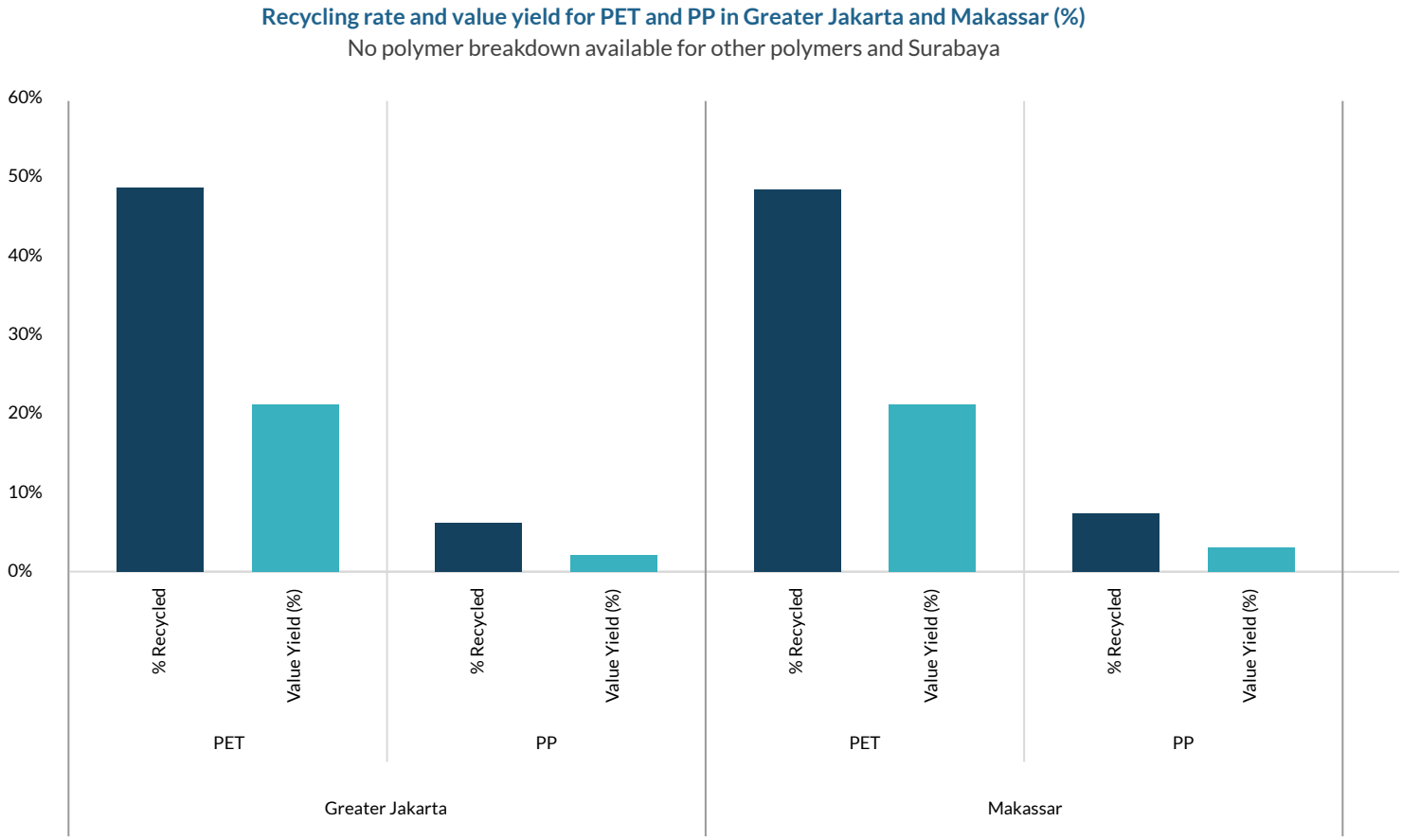
[64] The data for the remaining wastesheds and polymers were insufficient to carry out a comparison between recycling rates and plastic value yields of polymer collected for this study.

Figure 13: Plastic recycling rates vs. value yields in Indonesia.



Sources: Recycled pricing for individual polymers were obtained from research and interviews conducted. Virgin prices are virgin polymer price points from local producers (pre-Covid-19) from Circulate Capital - Safeguarding the Plastic Recycling Value Chain: Insights from Covid-19 impact in South and Southeast Asia (2020).

SUPPLY CHAIN ASSESSMENT

This section provides an overview and comparison of key aspects of the local plastic waste recycling supply chains in each wasteshed and the current barriers to recycling. An evaluation of each wasteshed in terms of different criteria identified to assess a well-functioning supply chain is presented in Table 2.

These indicators include the collected for recycling (CFR) rate, types of processes and infrastructure available, pricing transparency and regulatory framework. A high (green), moderate (amber), and poor (red) rating is assigned to each indicator depending on the status of the wasteshed, with a fuller description of the indicators provided in Appendix 1.

Table 2: Evaluation of supply chains in Greater Jakarta, Makassar and Surabaya using a red, amber, green rating approach.

Region	CFR Rate	Market Structure - Collection	Market Structure - Aggregation & Sorting	Market Structure - Recycling
	Main polymers being recycled are rigid PP & PET, but also some PE films and flexibles via Waste Banks or private collection initiatives. Majority of plastic waste is disposed in landfill or leaked into the environment.	National, regional and local administration provide collection services, but mainly rely on a bring bank (Waste Bank) system operated by neighborhood or community organizations (partially formalized) to collect recyclables.	Multitude of transfer, bulking and potential sorting stations (TPS3R/PKD, TPS/PSA and MRF) at the village, city and regional levels. An estimated 10 – 20% of TPS/3R are operational as planned sites for extraction of recyclables or organics before landfill disposal.	Formalized recycling infrastructure with medium to large scale recyclers for PET and PP as well as for recycling of PE flexibles.
Greater Jakarta	17%	DLH DKI (the Jakarta environment agency) oversees waste management but there is limited coordination with local administrations of individual cities. Est. 3,000 Waste Bank units.	Est. 90+ TPS 3R	Est. 1,300 recycling companies in Indonesia, but no regional breakdown available.
Makassar	17%	City Government of Makassar oversees waste management but there is limited coordination with local administrations of individual cities. Est 200 - 300 Waste Bank units with centralized 'Master' bank operated by the Environmental Agency in Makassar.	Est. 9 TPS 3R, and 16 key aggregators	Est. 1,300 recycling companies in Indonesia, but no regional breakdown available.
Surabaya	15%	Surabaya Municipal Government oversees waste management but there is limited coordination with local administrations of individual cities. Est. 200 Waste Banks units with a centralized 'Master' Bank.	Est. 9 TPS 3R and 190 TPST and seven key aggregators	Est. 1,300 recycling companies in Indonesia, but no regional breakdown available.

Legend: High Moderate Poor

Region	Pricing Transparency	Knowledge Gaps & Data Availability	Value Yield & Quality of Outputs	Regulatory Framework
	Poor pricing transparency with high number of informal collectors, Waste Banks and moderate number of aggregators.	Limited data availability. Main data sets were derived from a literature search of recent studies and supported by interviews.	There is considerable value loss for both rigid and flexible plastic waste, however Indonesia is collecting PE films at Waste Banks for recycling. Plastic value loss has been defined as the value of plastic collected based on virgin pricing against the value of plastics recycled based on recyclates prices for individual polymers.	Several policies are in place and there are plans to implement new regulations in the future though these are not fully enacted. For example, EPR principles are in place but is not enacted through regulations. Industry has put a voluntary PRO in place however.
Greater Jakarta	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators: PET 75%; LDPE, PP and HDPE 85%.	0-5 city studies per wasteshed providing sufficient data around MSW and plastic waste generation, PE film recycling and plastic waste supply chains. Limited city-level detail on waste treatment or polymer level details as studies mainly focussed on cities within Greater Jakarta, not the region as a whole.	Est. value yields: 23% for PET, no data available for other polymers	Jakarta Governor Decree No. 102 of 2021 on Garbage Management Obligations in Regions and Companies.
Makassar	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators: PET 75%; LDPE, PP and HDPE 85%.	0-5 city studies per wasteshed providing sufficient data around MSW and plastic waste generation, PE film recycling and plastic waste supply chains. Limited city-level detail on waste treatment or polymer level details as studies mainly focussed on cities within greater Jakarta, not the region as a whole.	Est. value yields: 23% for PET, no data available for other polymers	There are some regional regulations e.g. Regional Regulation Number 4 Year 2011, concerning waste management.
Surabaya	Market power or share of the profit margins/trade benefits held by recyclers/large aggregators: PET 75%; LDPE, PP and HDPE 85%.	0-5 city studies per wasteshed providing sufficient data around MSW and plastic waste generation, PE film recycling and plastic waste supply chains. Limited city-level detail on waste treatment or polymer level details as studies mainly focussed on cities within greater Jakarta, not the region as a whole.	No data available	Surabaya City Environmental Protection and Management Plan.

Legend: High Moderate Poor

THE NEED FOR INTERVENTION

Recognizing the gaps that are limiting the effectiveness of existing local plastic waste recycling supply chains across the wastesheds, this section outlines the need for intervention in terms of collection and aggregation, and plastic recycling and reprocessing.

Collection and Aggregation

Though door-to-door cart collection of waste is in place within each of the three wastesheds, the recycling of plastic is limited and predominantly relies on picking activities by informal waste workers, supported by ad hoc separation by collectors and the use of Waste Banks by local residents. An estimated 12% of waste and only 1.5% of plastic is recovered by Waste Banks (see section on Greater Jakarta for details).

Recycling infrastructure in the form of TPS 3R sites has been developed, but it is estimated that only 10-20% are currently operational. A key issue that extends to waste infrastructure more generally is a lack of funding. The national government spends 1% of the national budget on waste infrastructure and provincial governments allocate USD 5-6 per capita per annum. This is much lower than the international benchmark of USD 15-20 per capita per annum.[65]

Though there is a large amount of voluntary action on source segregation at the household level, in practice, further work to enforce and encourage change is needed, in particular to increase capabilities for collecting, sorting, and aggregating plastic waste from mixed waste at TPS 3R and TPA sites before landfill.

Plastic Recycling and Reprocessing

There is a good level of formal infrastructure in place for recycling plastic in each of the three wastesheds, including some capabilities for film recycling close to Surabaya. Currently, operational plants are all using mechanized processes.

However, the discrepancy between recycling capacity and recycled tonnage traced in the waste flows shows the difficulties in sourcing reliable volumes of good-quality plastic waste from households and small businesses via Waste Banks and informal collectors. The lack of more formalized sorting infrastructure limits the scale-up of plastic recycling and relies on recyclers and brands to build up their own separate supply chains, as the Veolia/Danone Aqua, Coca-Cola and Unilever examples show.

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[65] UNEP – *Plastic Pollution Policy Spotlight: Indonesia (2021).*

Recommendations for interventions

This section summarizes interventions that could be considered to improve local plastic waste recycling supply chains in terms of: improving collection rates, increasing sorting and segregation of plastics for recycling, and enabling growth in plastics recycling for a circular economy. The interventions are aimed at governments and industry to improve supporting regulatory and social conditions to create a stable policy framework. They cover financial interventions to improve value creation from plastic waste, as well as technical and digital improvements to increase supply chain efficiency.

The interventions presented in this section are generally similar as most wastesheds in a country encounter common challenges in terms of infrastructure gaps, fragmented supply chains, limited enforcement of regulations, and imbalance of market power between value chain stakeholders. Where appropriate, examples of models or interventions that could be applied in specific wastesheds are highlighted. The implementation pathways for these interventions were not part of the study and are not outlined in detail. Key interventions for consideration are summarized in Table 3 and described in more detail in the following sections.

Table 3: List of potential interventions to improve plastics recycling and increase value creation along the supply chain.

	Intervention categories →		
Desired supply chain impacts ↓	1. Improve supporting regulatory and social conditions to create a stable policy framework	2. Financial interventions to improve value creation from plastic waste	3. Technical and digital improvements to increase supply chain efficiency
Improve collection rates of plastics	Implement (harmonized) source segregated collection and EPR systems	Improve funding for formal waste collection infrastructure	*(Digitalize recyclable collection and material tracing, e.g., explore 'pay-as-you-throw' systems (PAYT) linked to material quality and level of segregation)*
	Awareness-raising and behaviour change campaigns e.g., to sort household waste, stop discharging bottles etc. into oceans	*(Support payment of informal sector: fair and prompt payment)*	
		(Subsidize formalization of informal pickers e.g., cooperatives, tax payments, permits, share EPR fees)	
Improve sorting of polymers and quality for recycling	Import restriction (bans, import fees) for mixed and low-value plastic waste	Invest in formal segregation and sorting infrastructure (public sector, FMCGs etc.) and integrate informal sector (employ waste pickers)	Upgrade existing sorting facilities with automated equipment
	(Introduce sorting and segregation quality standards for key waste streams as part of an EPR system)	*(Support payment of informal sector – financial incentives for good-quality recyclables)*	*(National or regional virtual marketplaces to improve pricing transparency and increase access for buyers)*
	(Mandate design for recycling standards to improve plastic and polymer separation as part of EPR)	Funding of automated/large-scale plastic segregation from mixed MSW prior to WtE/landfill (secondary sorting systems)	*(Fund paid for by private industry to provide grants for small-scale equipment: balers, sorting bays/containers, transport)*
Increase demand from plastic recyclers	Landfill disposal limits or bans, limitation of recyclables to WtE plants (pre-processing requirements for residual/wet waste)	*(Taxation of virgin content or tax relief for recycled content)*	-
		(Landfill or incineration taxes)	

Legend: Primary interventions/*(secondary interventions)*

IMPROVE COLLECTION RATES OF PLASTICS

Though there are some good examples of initiatives to increase recycling of plastic waste from households, further work is needed to ensure widespread change. This could include implementation of formalized door-to-door collection systems for recyclables, awareness-raising initiatives, and interventions to encourage the use of Waste Banks (e.g., increasing accessibility).

Increased funding for waste collection infrastructure is needed to encourage change. This could be delivered through further EPR funding (either through the current voluntary system or implementation of national regulation) or via changes to the level and allocation of household waste fees that are currently paid to neighborhood associations for collection. Alignment of national, regional, and local-level waste services and responsibilities will be needed to ensure effective change.

The majority of plastic waste recovery is being delivered through the informal sector, with individual workers being exposed to unsafe working conditions and no guaranteed compensation for their efforts. Improvement to infrastructure (such as TPS and TPS 3R sites) could provide an opportunity for more formalized employment along with fair pay and improved working conditions. Similarly, the creation of a more transparent marketplace via applications like Octopus could provide additional incentives for source segregation.

IMPROVE SORTING OF POLYMERS AND QUALITY FOR RECYCLING

The majority of waste is currently being landfilled with minimal recovery (only informal picking from transfer facilities (e.g., TPS, TPA etc.), and landfills. Upgrading capabilities for recovery post-collection could have a large impact on recovery rates. For example, upgrading TPS 3R sites into use (see details on the Dow/Waste4Change optimization program in Bogor in the Greater Jakarta section of the report) and ensuring they are suitably funded, staffed, and equipped, with automated equipment where feasible. In addition, capabilities of TPS sites could be upgraded to formalize recovery of recyclables, or new sites could be developed to pre-treat waste before landfill or WtE disposal (ideally supported by national legislation to enforce pre-treatment).

Waste Banks and aggregators currently play an important role in the recovery of plastic, but many are operating on a small scale. There may be scope to increase their capabilities through the provision of funding for balers or small compaction machinery to increase the amount of material managed.

There has been considerable critique from the Indonesian Plastics Recyclers (IPR) regarding the ban on plastic bags in Greater Jakarta and other cities and regencies, as this waste stream is collected at Waste Banks and via informal collectors in Indonesia due to its value. The IPR states that these monolayer bags are often recycled back into plastic or garbage bags, or made into cast buckets for the construction industry.[66]

A number of digital solutions are already being used to improve management of plastic waste, particularly incentivizing take-back. Future work could be undertaken to further develop this and to help improve pricing transparency, to show prices that can be expected from aggregators and provide virtual marketplaces for material to help increase availability and reduce the use of imports.

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[66] Indonesia Plastic Recyclers – *Plastic Bag Waste is Recyclable and of Economic Value (2019).*

INCREASE DEMAND FROM PLASTIC RECYCLERS

Existing policies provide a good framework for recycling in Indonesia. Regulations promoting EPR and target setting need to be supported by a clear funding and implementation program. Properly implemented, the EPR system could improve both segregation and recycling, and aid in the scale-up of recycling through establishment of formalized sorting infrastructure.

Currently, industries including packaging are using extended stakeholder responsibility principles, running voluntary initiatives to scale up the use of Waste Banks and collection schemes as part of companies' corporate social responsibility programs.

In August 2020, Coca-Cola, Danone, Indofood, Nestlé, Tetra Pak and Unilever created PRAISE (Packaging Recycling Association for Indonesia Sustainable Environment), which launched the Indonesia Packaging Recovery Organization (IPRO) program, a voluntary vehicle to implement EPR. It focuses on post-consumer collection (formal and informal) and recycling. IPRO funds three categories of initiatives:

A. Payments to aggregators or recyclers for proof of recycling and collection through incentives.

B. Provision of co-funding for the set-up of new collection and sortation systems in return for proof of new collection and/or recycling achieved over a defined period.

C. Finances enabling activities to support responsible expansion of categories A and B.

Indonesia is also the first country in the world to test drive the National Plastic Action Partnership (NPAP) model from the Global Plastic Action Partnership (GPAP). Set up by the World Economic Forum in 2018, it is a platform for translating plastic pollution commitments into concrete action. The national action plan and associated roadmap is expected to prevent 16 million tonnes of plastic waste from entering the ocean by 2040. NPAP Indonesia also leads the 'Innovation roadmap to radically reduce plastic pollution in Indonesia'. It was published in March 2021 with three task force priorities:[67]

1. Launch an Innovation Challenge in partnership with GPAP and the World Economic Forum.

2. Link new ideas to accelerators and incubators, such as The Incubation Network's Ocean Plastic Prevention Accelerator or CSIRO's Plastics Innovation Hub.

3. Create pre-competitive spaces for large producers and consumers to detail their needs to innovators, creating 'demand' for new innovations.

IPRO stated in August 2022 that it will be cooperating with national and regional governments in Indonesia to address waste management in urban areas via a multi-stakeholder approach. The organization 'is ready to work with industry or the private sector and local governments to establish waste collection and management facilities such as integrated waste management sites (TPST)'.[68]

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[67] Global Plastic Action Partnership – *NPAP Indonesia: Innovation Roadmap to Radically Reduce Plastic Pollution in Indonesia (2022).*

[68] Indonesia PRO – *Managing Waste in Indonesia, IPRO is Ready to Cooperate with Local Government (2022).*

Conclusion

The reviewed wastesheds in Indonesia have a dynamic and extensive network of collection and potential sorting sites; however, the domestic plastic waste flowing through the system into recycling is still small and it is currently competing with plastic waste imports, which are able to deliver quantities more reliably and often better quality, therefore easier to handle for recyclers.

The Indonesian 'bring system' approach in the form of Waste Banks is interesting as it enables the conversion of 'waste into money' as well as providing initial aggregation points for plastics. However, the coverage of Waste Banks across the wastesheds is still very low and often collected waste is either passed back to informal collectors/aggregators or formalized sorting infrastructure where available. Some of the collected waste also ends up converted into products on-site for the local community. While there is considerable scale-up potential for these Waste Banks, there is a need for more central Waste Banks that can aggregate collected plastics and more sorting infrastructure at TPS 3R and TPA level. Central Waste Banks have a key function as these are operated by the public sector (environment agency or local administration), which guarantees uptake and can provide fair pricing in line with market pricing and generate income, as well as aggregate plastics to be sold directly to recyclers where possible, avoiding additional aggregation costs.

While the mixed solid waste management services are fully controlled by the public sector, the study has shown that a multi-stakeholder approach involving private sector companies is increasingly used to plan, finance, and deliver new infrastructure, which is needed to support the regional and local administration.

The NPAP Financing Task Force states that 'an estimated USD 18.4 billion in investments must be mobilized for waste collection, recycling and disposal systems, of which USD 8 billion should be allocated to plastic waste. The costs for running the system would be around USD 1.8-2.2 billion per year.'[69] There are numerous initiatives to support Waste Banks, TPS 3R sites, and recycling and waste services being made by the Indonesian Government in its efforts to meet its ambitious targets. However, these are often small-scale and only partially address issues around funding and land distribution. Successful planning and delivery of new large-scale infrastructure is needed in all wastesheds to scale up plastic recycling supply chains.

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[69] Pace Circular – *Financing System Change to Radically Reduce Plastic Pollution in Indonesia: A Financing Roadmap Developed by the Indonesia National Plastic Action Partnership (2020).*

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Appendix 1: Supply chain assessment indicator descriptions and rating scales

Criteria to assess a well-functioning supply chain	Benchmark for good standard
CFR rate for plastic waste: Plastics collected for recycling (CFR) out of plastics collected in MSW.	>30% 15-30% < 15%
Market structure - Collection: Proportion of plastic collected for recycling via the formal sector.	Majority of plastics collected for recycling via the formal sector with a good level of formalized infrastructure for source segregated collection. % of plastics collected for recycling by the formal sector: >50% 25-50% < 25%
Market structure - Aggregation & sorting: Proportion of plastic aggregated/sorted for recycling via the formal sector.	Majority of plastics collected for recycling is being aggregated and sorted by the formal sector with a good level of formalized infrastructure for bulking and sorting of plastics for recycling. >50% 25-50% < 25%
Market structure - Plastic recycling: Proportion of formal vs. informal recyclers and 'fair' competition.	Majority of plastics collected is being recycled in permitted, formal sector facilities. >50% 25-50% < 25%
Pricing transparency: Pricing transparency as an economic concept refers to the degree to which pricing information is available to all buyers and sellers in a market. A high level of pricing transparency ensures healthy competition, efficient markets, and better pricing of products, and is often considered an indicator of an efficiently operating supply chain, which enables growth.	High transparency: with a good level of pricing information and similar number of buyers and sellers. Moderate or poor transparency: with a medium level of pricing information and disproportionate number of buyers and sellers. Ranking based on market power or share of the profit margins/trade benefits held by recyclers/large aggregators: < 50% 50-75% 75%
Knowledge gaps and data availability: Availability of and confidence in data on waste flows, ecosystems and transactions. This relies on the amount, recency and quality of data available from trusted sources, such as local and national government reports, EPR system data and trusted industry bodies.	High: Multiple recent data and information sources available from reputable sources – >10 city studies with detailed, verified waste flow data. Moderate: Some data is available but it is less recent or is from less reputable sources – 5-10 city studies with some verified waste flow data. Poor: No/extremely limited data and information sources available; data is not recent or there are considerable discrepancies between different sources – 0-5 city studies with contradictory or unverified data sets.
Value yield and quality of outputs: Estimated value of plastics recycled based on local recyclate pricing/estimated value of plastics collected based on virgin polymer prices.	>50% 25-50% < 25%
Regulatory framework: Waste management policies, permitting systems, funding and fiscal incentives that are driving the collection, segregation, and recycling of plastics. Level of implementation of EPR systems, plastics taxation, and other specifically targeted measures.	High: Suitable national (or local) legislation in place, which has been implemented and is functioning well in practice. Moderate: Some suitable national (or local) legislation is in place, though it has not been fully implemented in practice. Poor: Suitable national legislation (and local legislation) is not yet established/is in very early stages of development.

Legend: High Moderate Poor

Appendix 2: List of potential interventions

Full list of potential interventions to improve plastics collection rates and increase value creation along the plastic waste supply chain.

	Intervention categories →		
Desired supply chain impacts ↓	1. Improve supporting regulatory and social conditions to create a stable policy framework	2. Financial interventions to improve value creation from plastic waste	3. Technical and digital improvements to increase supply chain efficiency
Improve collection rates of plastics	Implement (harmonized) source segregated collection and EPR systems.	Increased waste collection fees/levies charged to households.	Digitize recyclable collection and material tracing; for example, explore 'pay-as-you-throw (PAYT) systems' linked to material quality and level of segregation.
	Improve welfare standards of informal workers (annual health check-ups, PPE, insurance etc.).	Improve funding for formal waste collection infrastructure.	Smart bins, underground containers etc. to reduce collection costs and maximize space and access (linked to registered informal collectors).
	Registrations or permits for informal waste pickers with the incentive to receive tools/equipment, access to loans, PPE etc. to build capacity.	Support payment of the informal sector (fair and prompt payment).	
	Central registry of official collection points for specific plastics/waste formats.	Market incentive payments for hard to recycle, low-value waste formats and polymers.	
	Awareness-raising campaigns and behavior change e.g., to sort household waste, and stop discharging bottles etc. into seas and oceans.	Fund/incentivize take-back schemes via retailers, hospitality and transport sectors.	
		Subsidize formalization of informal pickers (cooperatives, tax payments, permits, share EPR fees).	
Improve sorting of polymers and quality for recycling	Clear administrative pathways for operating permits for sorting and aggregation.	Invest in formal segregation and sorting infrastructure (public sector, FMCGs etc.) and integrate the informal sector (employ waste pickers).	National or regional virtual marketplaces to improve pricing transparency and increase access for buyers.
	Mandate design for recycling standards to improve plastic and polymer separation (part of EPR).	Support payment of the informal sector – financial incentives for good quality recyclables.	R&D funding for innovative plastics/polymer sorting technologies (NIR, AI etc.).
	Introduce sorting and segregation quality standards for key waste streams (as part of an EPR system).	Plastic collection and sorting credits/incentives (as part of an EPR system).	Upgrade existing sorting facilities with automated equipment.

Appendix 2: List of potential interventions (continued)

	Intervention categories →		
Desired supply chain impacts ↓	1. Improve supporting regulatory and social conditions to create a stable policy framework	2. Financial interventions to improve value creation from plastic waste	3. Technical and digital improvements to increase supply chain efficiency
Improve sorting of polymers and quality for recycling	Import restrictions (bans, import fees) for mixed and low-value plastic waste.	Improve funding for environmental regulators and protection agencies.	Digital certification and tracing of sorted plastics waste and polymers.
	Comprehensive monitoring and enforcement of environmental regulations/permits.	Tax relief for sorting and segregation equipment and facilities.	Fund paid for private industry to provide grants for small-scale equipment: balers, sorting bays/containers, transport.
	Central registry and master planning of segregation and sorting of plastics and polymers for recycling.	Subsidize formalization of informal or small-scale aggregators (cooperatives, tax payments, permits).	
		Funding of automated/large-scale plastic segregation from mixed MSW prior to WtE/landfill (secondary sorting systems).	
Increase demand from plastic recyclers	Mandate recycled content targets in key applications (incl. rigid and flexible packaging).	Invest in medium- to large-scale plastics recycling of mixed and hard to recycle plastics.	National or regional virtual marketplaces to improve supply chain security.
	Clear administrative pathways for operating and building permits for recycling facilities.	Subsidize formalization of informal/small-scale recyclers (cooperatives, tax payments, permits).	R&D funding for innovative plastics recycling technologies.
	Green/sustainable public procurement policies and funding support for regional plastic recycling projects.	Improve funding for environmental regulators and protection agencies to ensure a level playing field.	
	Export restrictions (bans, fees) for collected and segregated plastic waste.	Tax relief for plastics recycling equipment and facilities.	
	Landfill disposal limits or bans, and limitation on recyclables to WtE (pre-processing requirements for residual/wet waste).	Quality standards for recycled plastics incentivizing circular recycling (plastic credits for hard to recycle plastics, high recycling yields, closed loop recycling).	
		Taxation of virgin content or tax relief for recyclate content.	
		Landfill or incineration taxes.	

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The Circulate Initiative