

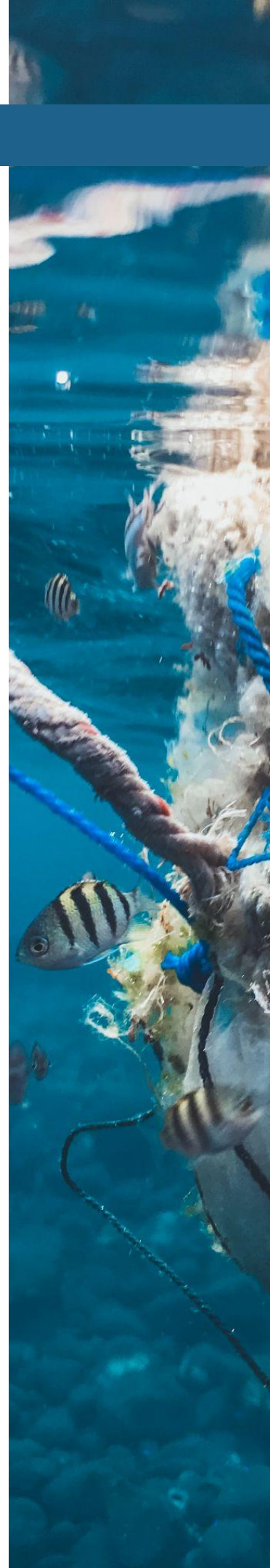
JANUARY 2023

Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in India, Indonesia, Thailand and Viet Nam



Contents

Executive Summary	04
Mapping local plastic recycling supply chains: Summary Insights from India	07
‣ Insights on local plastic recycling supply chains in Delhi	
‣ Insights on local plastic recycling supply chains in Mumbai	
‣ Insights on local plastic recycling supply chains in Chennai	
‣ The need for intervention	
Mapping local plastic recycling supply chains: Summary Insights from Indonesia	15
‣ Insights on local plastic recycling supply chains in Greater Jakarta	
‣ Insights on local plastic recycling supply chains in Makassar	
‣ Insights on local plastic recycling supply chains in Surabaya	
‣ The need for intervention	
Mapping local plastic recycling supply chains: Summary Insights from Thailand	23
‣ Insights on local plastic recycling supply chains in Bangkok	
‣ Insights on local plastic recycling supply chains in Chon Buri	
‣ Insights on local plastic recycling supply chains in Rayong	
‣ The need for intervention	
Mapping local plastic recycling supply chains: Summary Insights from Viet Nam	31
‣ Insights on local plastic recycling supply chains in Hanoi	
‣ Insights on local plastic recycling supply chains in Ho Chi Minh City	
‣ Insights on local plastic recycling supply chains in Da Nang	
‣ The need for intervention	
References	39
Acknowledgements	41



General abbreviations

EPR	Extended producer responsibility
KT/yr	Kilo tonnes (or thousand tonnes) per year. Metric tonnes are used.
MRF	Material recovery facility
MSW	Municipal solid waste
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

BACKGROUND

Though many urban areas of India, Indonesia, Thailand, and Viet Nam have municipally-managed waste collection, there remains a high reliance on the informal sector for the collection, aggregation, and recycling of plastic and other valuable materials. Plastic recycling supply chains are local and unique as they rely on these informal transactions, which are driven by local conditions, traditions, and cultures, as well as local and regional infrastructure and markets.

Recognizing the need to explore plastic supply chains in more localized contexts and understand the conditions required for the supply chains to be more effective, The Circulate Initiative, in partnership with Anthesis Group, conducted a detailed assessment of wastesheds¹ in India, Indonesia, Thailand, and Viet Nam. The wasteshed areas were selected to include: the capital city of each country; mega or large cities with existing and functional plastic recycling supply chains (established); and regions with considerable plastic waste generation and emerging plastic recycling supply chains (emerging).

The objectives of the 2022 study were to:

- ▶ Understand the local plastic recycling supply chains, including the key actors, infrastructure, and influencing regulations, particularly for four polymers - PET, HDPE, LDPE, and PP.
- ▶ Understand the economics for recycled 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.

The study focused on plastic in 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 insights were gathered through on-ground research - interviews conducted with local supply chain actors², as well as, organizations privy to local arrangements, and review of publicly available literature. Anthesis Group, the lead research partner for the study was supported by in-country partners³ in each country to carry out the local interviews.

This document provides a summary of the key findings for each of the wastesheds covered in this study, including aspects of the plastics recycling supply chains where improvements can be made. While certain aspects of wastesheds are unique, most wastesheds in a country encounter common challenges in terms of infrastructure gaps, fragmented supply chains, limited enforcement of regulations, and an imbalance of market power between value chain stakeholders. As a result, the interventions presented are generally similar and where appropriate, examples of models or interventions that could be applied in specific wastesheds are highlighted in the respective country reports.

Detailed insights into material flows, the ecosystem of actors, pricing and interventions are provided in the four respective country reports; links to which have been provided in this summary.

¹ 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. The wastesheds broadly reflect the boundaries of the selected cities, though there is some fluidity as 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.

² Interviews were conducted with 59 collectors, 45 aggregators, and 21 recyclers.

³ The in-country partners are Evergreen Labs for Viet Nam, PRO India for India, Rebel (with Waste4Change) for Indonesia, and the Stockholm Environment Institute (SEI) for Thailand.

KEY HIGHLIGHTS AND RECOMMENDATIONS

The reviewed wastesheds in India (Delhi, Mumbai, and Chennai) have well-established informal plastic waste recycling systems, which enable considerable amounts of plastic recycling to be carried out via a network of entrepreneurial relationships and micro-businesses, especially in Delhi. However, these informal systems also have environmental and welfare issues, which need to be addressed.

The reviewed wastesheds in Indonesia (Greater Jakarta, Makassar, and Surabaya) have a dynamic and extensive network of collection and potential sorting sites, such as Waste Banks (Bank Sampah), TPS (temporary shelter), TPS 3R (material recovery facility), and TPST (integrated waste management site). However, the domestic plastic waste flowing through the system into recycling is still small and it is currently competing with plastic waste imports.

The reviewed wastesheds in Thailand (Bangkok, Chon Buri, and Rayong) show that the market structure for recycling is strong, with multiple companies having developed formal treatment capacity for recycling. However, all wastesheds still rely on the informal sector for collection of recyclables.

In Viet Nam's selected wastesheds (Hanoi, Ho Chi Minh City, and Da Nang), the supply chains are similar due to the strong role of the national and local governments in the waste management sector, with limited contracting and involvement of the private sector. Ho Chi Minh City has the most established and best performing local supply chain for plastic waste recycling, followed by Hanoi. Though some plastic waste collection is present, the supply chain in Da Nang requires the greatest support to scale up in future.

For local plastic supply chains in all four countries to be more effective, several conditions must be in place. These include demand from buyers for recyclates, which needs to be matched by the supply of good-quality plastic waste feedstock; the right regulatory and policy framework, and implementation measures from source segregation to collection and processing; and transparent pricing for a more equitable distribution of value across the supply chain. Handling practices at each stage of the supply chain need to be efficient and conducted in a socially- and environmentally-friendly manner.



WASTESHED IN NUMBERS

PLASTICS WITHIN MSW

INDIA



	Delhi	Mumbai	Chennai
Collected (KT/yr)	562	119	140
Recycled (KT/yr)	337	24	28
% recycled	60%	20%	20%

INDONESIA



	Greater Jakarta	Makassar	Surabaya
Collected (KT/yr)	724	58	85
Recycled (KT/yr)	126	10	13
% recycled	17%	17%	15%

THAILAND



	Bangkok	Chon Buri	Rayong
Collected (KT/yr)	879	185	48
Recycled (KT/yr)	134	27	7
% recycled	15%	14%	14%

VIET NAM



	Hanoi	Ho Chi Minh City	Da Nang
Collected (KT/yr)	548	706	85
Recycled (KT/yr)	108	145	17
% recycled	20%	21%	20%

—
Note: Figures are rounded to the nearest whole number.



In India, although the formal sector achieves a high collection rate of around 60% for plastic waste, over an estimated 30% is mismanaged i.e. littered, or informally burned or dumped.⁴

The reviewed wastesheds, Delhi, Mumbai, and Chennai, have well-established informal plastic waste recycling systems, which enable considerable amounts of plastic recycling to be carried out via a network of entrepreneurial relationships and micro-businesses, especially in Delhi. However, these informal systems also have environmental and welfare issues, which need to be addressed.

The Indian Government has implemented legislation since the early 2000s to increase the recycling of plastic waste and prevent plastic pollution. The supporting regulatory framework is one of the key drivers to improve the wastesheds' sorting infrastructure and potentially channel a supply of plastic waste from the 'formal' sector via Material Recovery Facilities (MRFs) and transfer stations. This could provide considerable scale-up for the plastics supply chain across the wastesheds in India.

The detailed insights are provided in the report, [Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in India](#).

⁴ TERI – *Circular Economy for Plastics in India: A Roadmap* (2021).

Insights on local plastic recycling supply chains in Delhi

An estimated 60% or 337 KT/yr of plastic waste collected in municipal solid waste (MSW) is recycled in Delhi. Almost all plastics recycled are collected by informal waste pickers, and through take-back systems for plastic bottles operated by producer responsibility organizations (PROs).

Delhi has three municipal zones or Urban Local Bodies (ULBs), responsible for municipal waste management.⁵ Each municipal zone manages MSW collection or contracts private players to manage and operate MSW collection and transportation. Formal waste collection in Delhi starts with door-to-door collection by local municipal collectors (sanitation workers), or independent (contracted) rickshaw collectors, depending on the different areas in Delhi.

The mixed waste is brought to formal transfer stations, then either to an MRF or sent directly to either of two operational landfills, where majority of the formally collected material ends up, or other disposal facilities. Delhi has three operational Waste to Energy (WtE) plants.

There are 151 MRFs operating in Delhi; however, there is no expectation that materials sent to MRFs go to recycling. At the MRF, recyclable materials are sometimes separated from non-recyclables, and the sorted plastic waste is sent to scrap dealers, where it enters the informal waste management system or goes directly to recycling.

The informal sector comprises an estimated 200,000-500,000 waste collectors and itinerant waste buyers.^{6,7} Informal waste pickers collect recyclable waste at different stages of the formal waste supply chain, from households, offices, shops, streets, transfer stations and landfills by foot, tricycle or bicycle. Non-recyclable materials are sent to formal waste transfer stations, while recyclable material is sold to local scrap dealers (Kabadiwalas), where waste is sorted into five to 15 streams.

Further segregation takes place along different stages of aggregators until it reaches more specialized facilities, which sell waste to agents. Larger aggregators (agents) coordinate and manage the sale of recyclable plastic waste to recycling facilities.

An estimated 315 recycling facilities in and around Delhi mainly process rigid plastic waste, but also some flexible LDPE.⁸ Many recyclers are small-scale with 10 or more employees. Delhi's main recyclers are located in Narela or Bawana, or just outside the city in surrounding areas.

Delhi has a good level of door-to-door collection, a large informal collection and aggregation sector, as well as considerable plastic recycling infrastructure within the city and surrounding areas. Efforts to improve sorting and segregation at MRFs should further improve rates and overall plastic recycling.

⁵ The original five ULBs were reduced to three (Municipal Corporation of Delhi, Delhi Cantonment Board and New Delhi Municipal Council); however, the data provided for this study mainly relates to the original five zones.

⁶ International Alliance of Waste Pickers - *City Report: Interview with a local waste picker (2014)*.

⁷ Hasiru Dala - *What is the mainstream waste system (2018)*.

⁸ Delhi Pollution Control Committee - *Annual Report for the Year 2020-2021*.



Figure 1: Flow of plastic within municipal solid waste in Delhi (thousand tonnes per year). 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 share of plastics collected in Delhi is calculated based on a 100% MSW collection rate.

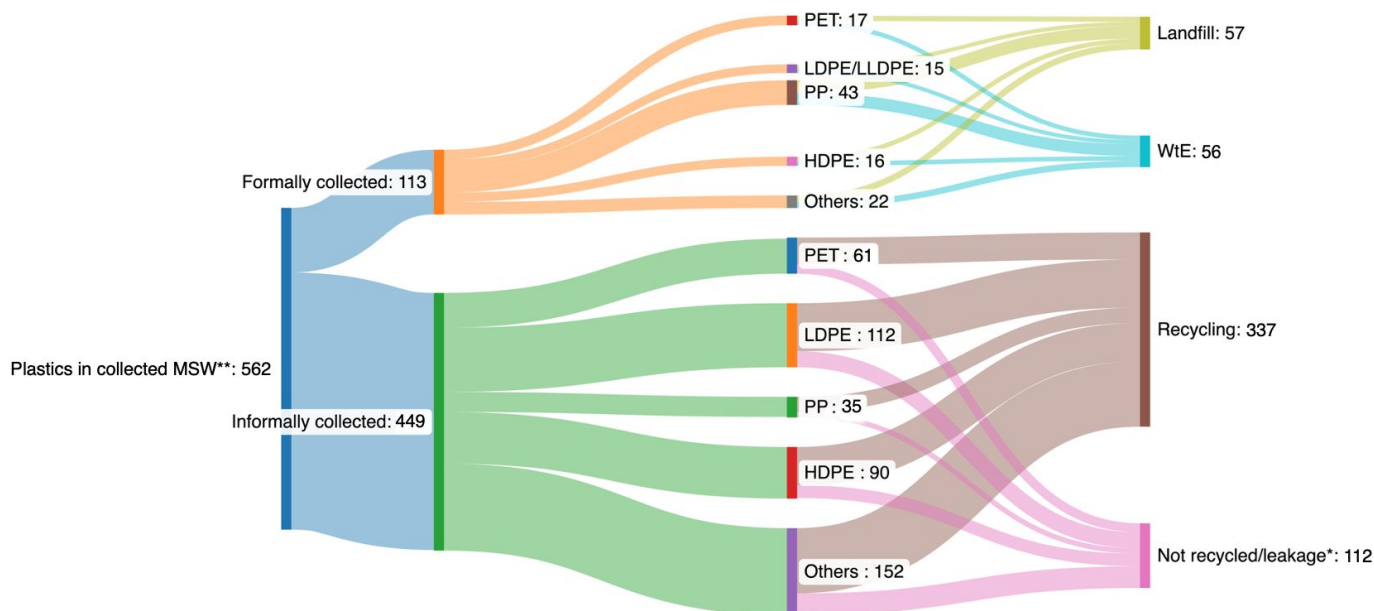
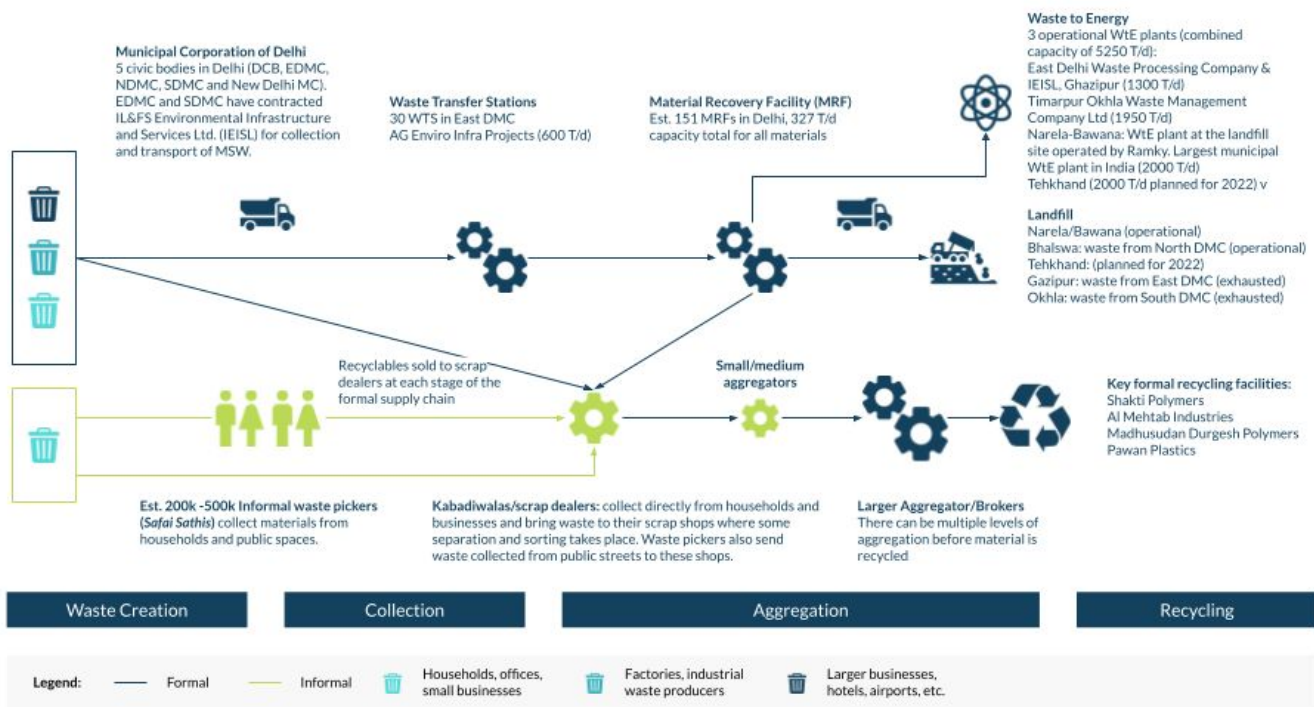


Figure 2: The plastic waste supply chain in Delhi.



Insights on local plastic recycling supply chains in Mumbai

Mumbai has an estimated 20% or 24 KT/yr of plastics collected in MSW that is recycled. There is a heavy reliance on informal collectors supported by non-governmental organizations (NGOs) and waste pickers' associations to organize municipal waste collection and sorting for transfer and recycling, as many areas are not accessible to the formal collection vehicles.

The Brihanmumbai Municipal Corporation (Greater Mumbai Municipal Corporation – BMC) has introduced several policies to improve waste management and address plastic waste. In 2018, a regional ban on single use plastics was introduced by the Maharashtra Government as part of which, dairies are also required to develop a deposit return scheme, with a buy-back price of no less than INR 0.50 per milk pouch to then be recycled.⁹

The BMC collects waste in vehicles with two compartments to allow wet and dry waste to be separated. The dry materials are sent (usually via a transfer station) to an MRF for sorting. Due to differing levels of automation, some MRFs achieve a higher level of segregation than others. Typically, however, high-value recyclables, including HDPE, PP, LDPE, and PET, are extracted and sent to larger private aggregators for further segregation and consolidation. The plastic is then sold to recyclers.

Formal collection and segregation is challenging in Mumbai as a number of areas in the city are not accessible to the BMC vehicles. In these areas, communal bins are used, and informal collectors, supported by NGOs, collect material door-to-door and transport it to the bins. The material is not currently segregated for recycling. Plastic waste collected from households by these informal collectors or plastics picked from public locations and landfills are then sold on to *Kantawallahs*, small local aggregators who often also undertake collections, before onward sale to larger aggregators and ultimately recyclers.

Mumbai does not have many registered recyclers and most of these are small. There is a large informal recycling sector, with an estimated 1,500 units processing plastics. Plastic waste is also transported to Gujarat, a state with a recycling hub located about 120 km from Mumbai. Any plastic waste not recovered is landfilled at one of two landfill sites. WtE treatment options have been explored and there are plans for a 600 MT/d facility to be situated at the Deonar landfill.¹⁰

Mumbai's recycling rate is considerably lower than Delhi's. This could be due to lower MSW collection rates, and the lower coverage of the city by waste pickers and sorting at MRFs, or a lack of demand from local recyclers as plastic waste is being transported to Gujarat. Collection and aggregation seem to be less efficient than in Delhi, and sorting at MRFs needs to be improved to increase the plastic waste made available for recycling.



⁹ Indian Express – *Plastic ban: Most dairies in Maharashtra yet to start buying back and recycling of milk pouches* (2019).

¹⁰ Mid-day, Mumbai – *After bio-waste plant, Deonar waste-to-energy plant also spells trouble* (2022).

Figure 3: Flow of plastic within municipal solid waste in Mumbai (thousand tonnes per year). 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 share of plastics collected in Mumbai is calculated based on an 81% MSW collection rate.

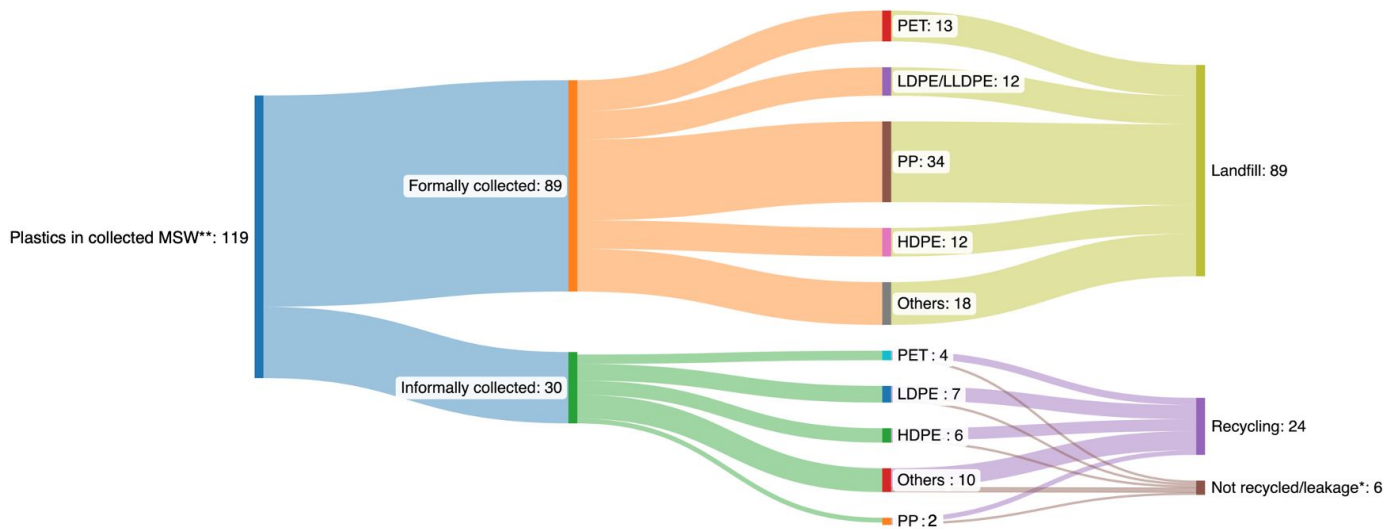
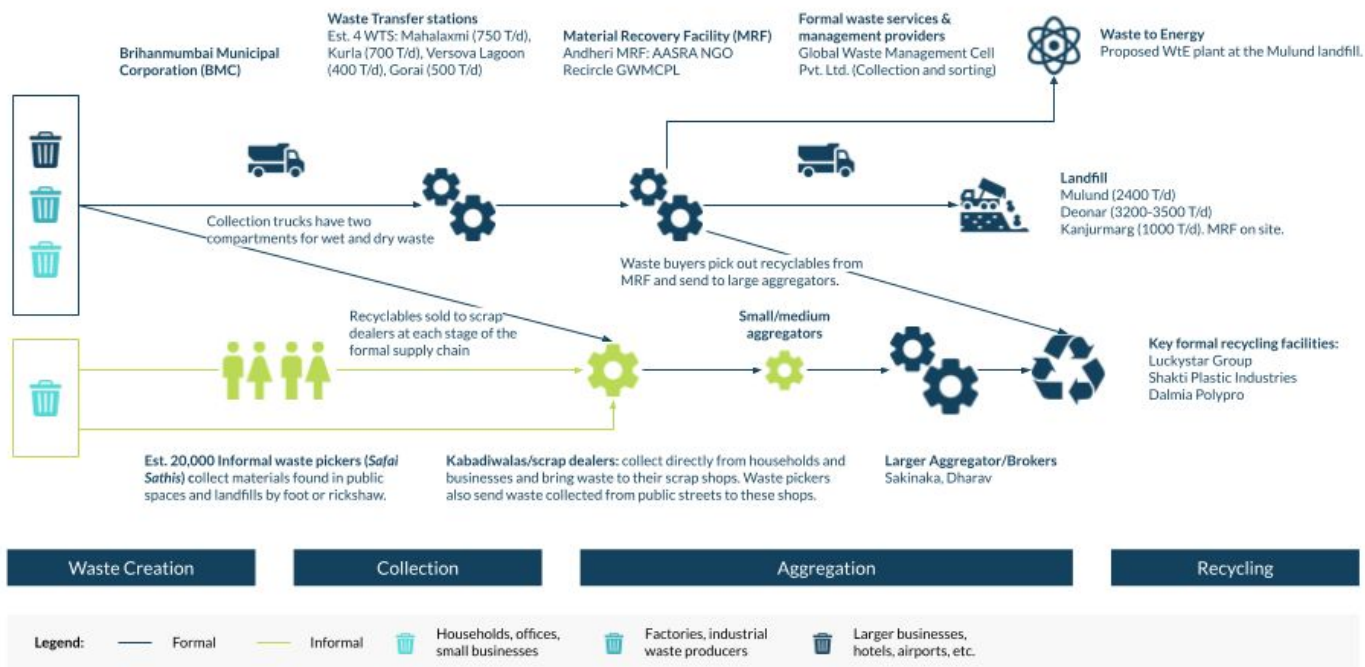


Figure 4: The plastic waste supply chain in Mumbai.



Insights on local plastic recycling supply chains in Chennai

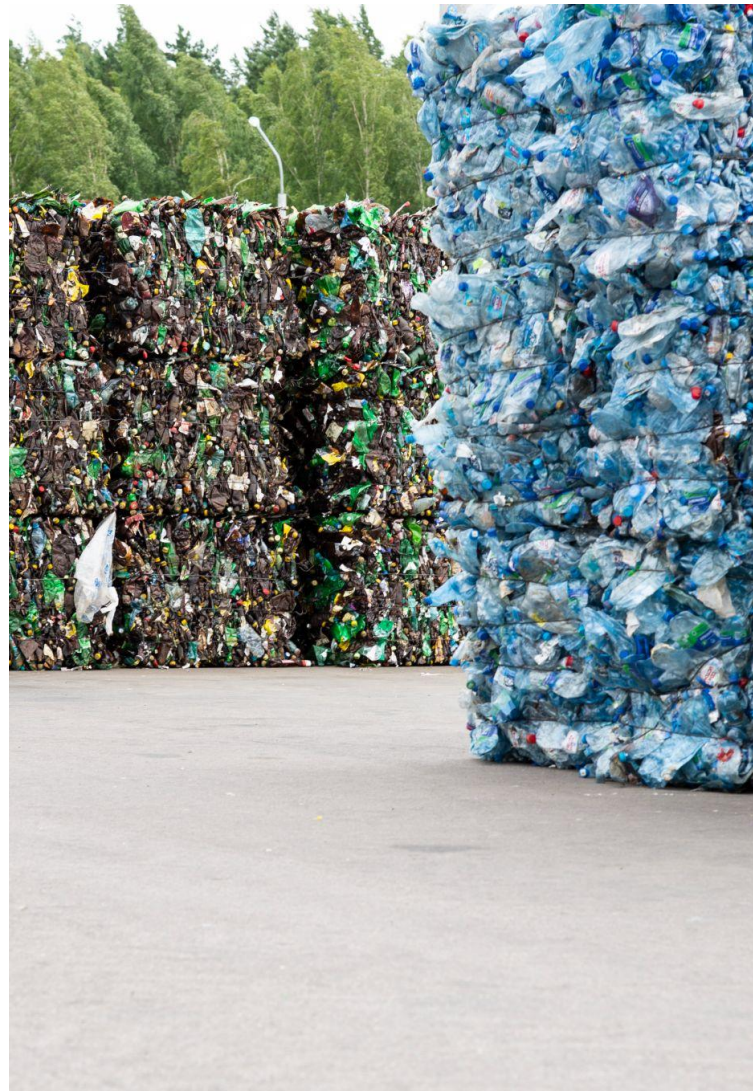
Chennai has an estimated 20% or 28 KT/yr of plastic waste collected in MSW that is recycled. There are efforts to make segregation mandatory and, unlike in Delhi and Mumbai, there are no large aggregators.

The Greater Chennai Corporation oversees MSW management in Chennai and outsources collection and transportation to private companies, Urbaser-Sumeet and Ramky Enviro.^{11 12} In 2016, the city corporation mandated households to segregate dry, wet and hazardous waste into color-coded bins provided by the municipality, with penalties to be handed out to those who fail to comply, though implementation seems to be delayed.¹³

In Chennai, an estimated 95% of households are covered by door-to-door collection, involving 850 trucks collecting mixed waste, which is sent to seven transfer stations with a total capacity of 3.7 KT/d, then to MRFs.¹⁴ From the estimated 110 MRFs in Chennai, waste is sent to two landfills. Waste is also sent to a WtE plant, and two additional WtE plants are planned.¹⁵

Informal waste collection drives recycling in Chennai, with an estimated 10,000 waste collectors, 5,400 of which transport waste using tricycles or bicycles. An estimated 20-25% of the MSW is collected by waste pickers in Chennai, which will be mostly recycled.¹⁶ Recyclable plastic waste is sold to scrap dealers, who separate plastic into different streams to be sold to aggregators.

Unlike Delhi and Mumbai, Chennai does not have large aggregators. Smaller recyclers often buy plastic waste directly from scrap dealers or informal sector organizations. The recycling industry in Chennai focuses mainly on rigid plastics as there are few flexible plastic recyclers; however, some flexible plastic waste collected in the city is transported to the state of Gujarat for recycling.



¹¹ The Hindu Business Line – Ramky Enviro in a 7-year waste management contract in Chennai (2021).

¹² Urbaser – Urbaser Extends its International Presence with New Contracts in Asia and Latin America (2020).

¹³ Times of India – Chennai’s waste management to go hi-tech (2020).

¹⁴ Greater Chennai Corporation – Solid Waste Management (2022).

¹⁵ Central Pollution Control Board Delhi - Annual Report 2019-20.

¹⁶ Interviews with local value chain participants , October 2022.

Figure 5: Flow of plastic within municipal solid waste in Chennai (thousand tonnes per year). 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 share of plastics collected in Chennai is calculated based on a 96% MSW collection rate.

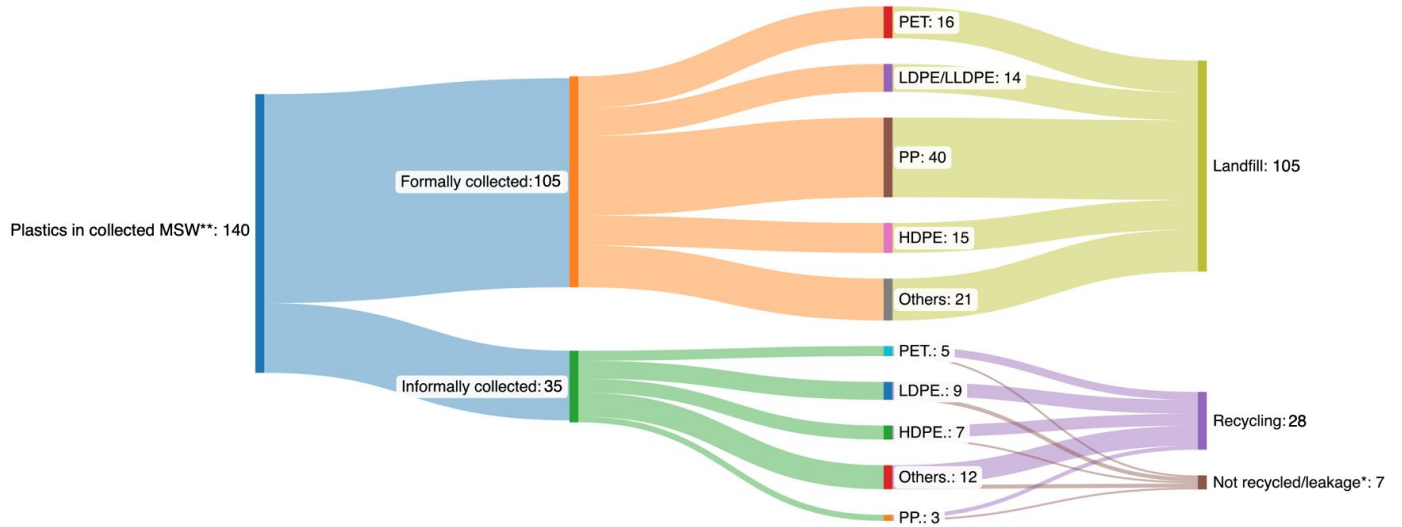
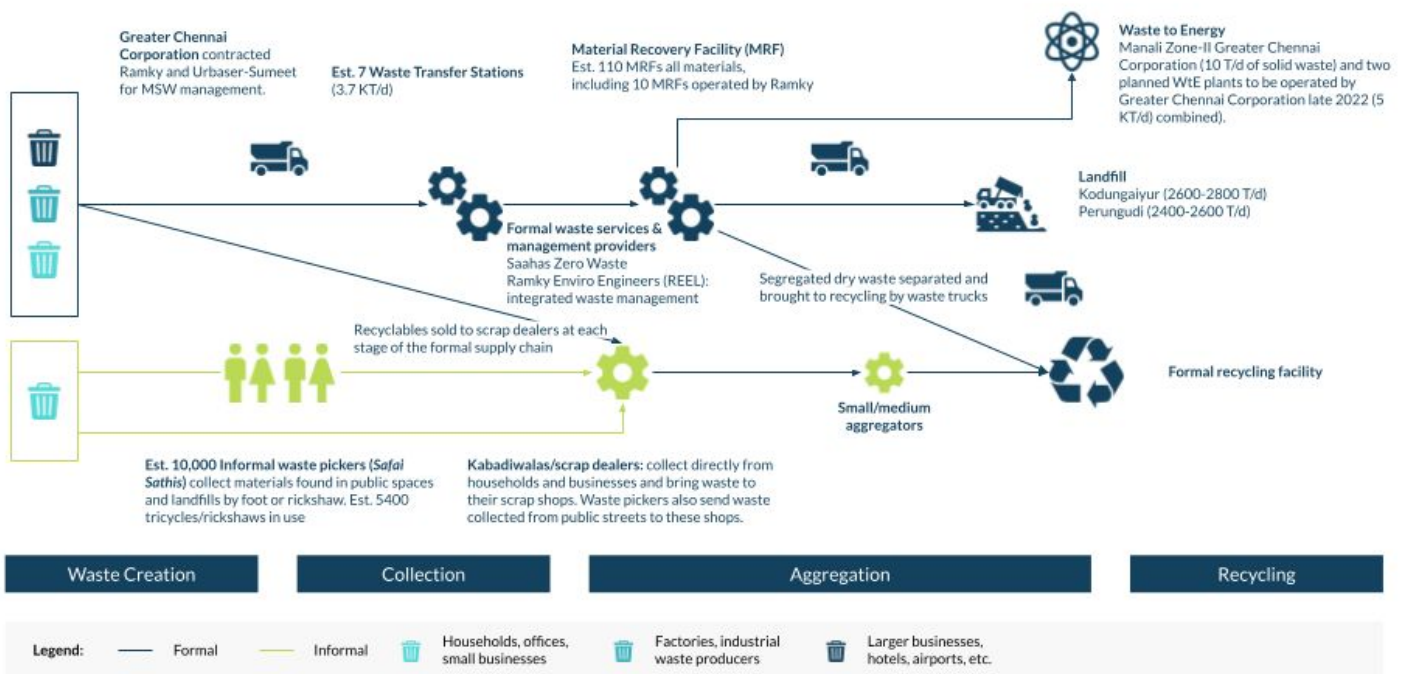


Figure 6: The plastic waste supply chain in Chennai.



The need for intervention

Recognizing the gaps that are limiting the effectiveness of existing local plastic waste recycling supply chains across the wastesheds, the following outlines the challenges and the interventions that could be considered to improve collection rates, increase sorting and segregation of plastics for recycling and enable growth in plastics recycling for a circular economy in Delhi, Mumbai and Chennai. The interventions summarized below are aimed at governments and industry and are identified to be generally similar across wastesheds, given the common challenges faced in terms of infrastructure gaps, fragmented supply chains and limited enforcement of regulations.



Mapping local plastic recycling supply chains: Summary Insights from Indonesia



It is estimated that across Indonesia, 60% of urban residents have access to waste collection services, despite efforts to improve the waste management services.¹⁷ Only 10% of plastic waste across Indonesia is sent to recycling facilities, with the vast majority of plastics collected for recycling managed through the informal sector.¹⁸ The remainder is landfilled, illegally dumped or burnt.

The reviewed watersheds in Indonesia, Greater Jakarta, Makassar, and Surabaya, have a dynamic and extensive network of collection and potential sorting sites, such as Waste Banks (Bank Sampah), TPS (temporary shelter), TPS 3R (material recovery facility), and TPST (integrated waste management site).¹⁹ 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 of better quality, therefore easier to handle for recyclers.

Indonesia has several waste management regulatory policies in place and there are plans to implement new regulations, though these are not fully enacted. Successful planning and delivery of new large-scale infrastructure is needed in all watersheds to scale up plastic recycling supply chains.

The detailed insights are provided in the report, [Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Indonesia](#).

¹⁷ 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).

¹⁸ 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).

¹⁹ Waste Banks: semi-formal facilities managed by local communities/neighborhoods.

TPS or *Tempat Penampungan Sementara*: receives waste before it is sent to a recycling site, processing site, TPST or TPS 3R.

TPS 3R (Reduce, Reuse, Recycle) site: meant to support aggregation and sorting of formally collected waste, to reduce quantity and improve characteristics of waste before being further processed at the landfill sites (TPA).

TPST or *Tempat Pemrosesan Sampah Terpadu*: place for collecting, sorting, reusing, recycling, processing, and final processing of waste. TPST has a more complex waste processing system compared to TPS 3R.

Insights on local plastic recycling supply chains in Greater Jakarta

An estimated 17% or 126 KT/yr of plastic collected from MSW is recycled in Greater Jakarta, with nearly all being handled through the informal sector, which includes Waste Banks and informal 'door-to-door' collection, as well as waste picking from landfills.

DLH DKI (the Jakarta Provincial 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. Formalized waste collection focuses on the control of waste and its transportation to landfills to avoid local environmental issues associated with illegal dumping, open burning and other polluting waste activities.

Greater Jakarta is estimated to host over 3,000 Waste Banks. There has been considerable growth in Waste Banks accepting and sorting recyclables, supported by private and voluntary organizations, as well as the regency governments. These Waste Banks manage 1,000 T/d of recyclables, approximately 12% of Jakarta's total waste, and 1.5% of total inorganic waste (plastic and paper).

The remainder of MSW is either collected by informal collectors as recyclables, or formally collected and mainly sent to TPA and landfill sites.²⁰ Each administration operates their own final disposal sites (TPA or TPS), which process 600-2,000 T/d of waste, and has TPS 3R sites; however, only 10-20% of the TPS 3R sites are operational.²¹ Bantar Gebang landfill, one of the main landfill disposal sites in Greater Jakarta, is running out of capacity. Currently there is a lack of alternative treatment methods for waste, and construction of five new WtE plants is planned, but progress has been slow.

Key formal recyclers of PET and other rigid plastic waste in the area include Indorama and PT Polindo in Tangerang. The identified recycling capacity in the wasteshed (an estimated 147.5 KT/ yr in Tangerang) is larger than the anticipated recycled tonnage traced in the waste flows, likely due to a combination of limited waste data availability, recyclers processing post-industrial and imported plastic waste, and individual processors setting up parallel collection schemes at locations like hospitality venues and transport hubs.

Greater Jakarta is a key area for private sector initiatives and a multi-stakeholder approach is increasingly used to plan, finance and deliver new infrastructure needed to support the regional and local administration. Amongst the cities and regencies in Greater Jakarta, 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. However, the wasteshed level analysis can only provide an initial insight into the plastic waste supply chains in Greater Jakarta and its cities and regencies, due to limited publicly available data and limitations on the number of surveys conducted with local stakeholders within the scope of this research.



²⁰ Ekuatorial - Waste banks, one of the solutions in waste management (2022).

²¹ Information provided by in-country research partner Rebel/Waste4Change.

Figure 7: Flow of plastic within municipal solid waste in Greater Jakarta (Thousand tonnes per year).^{22,23} 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.

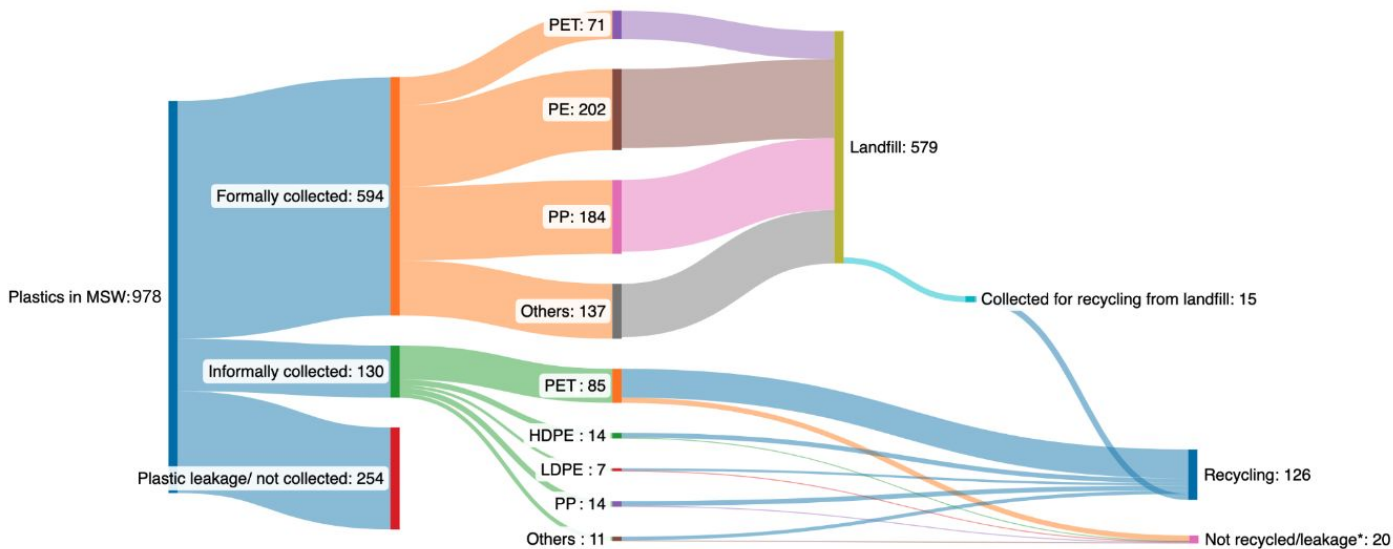
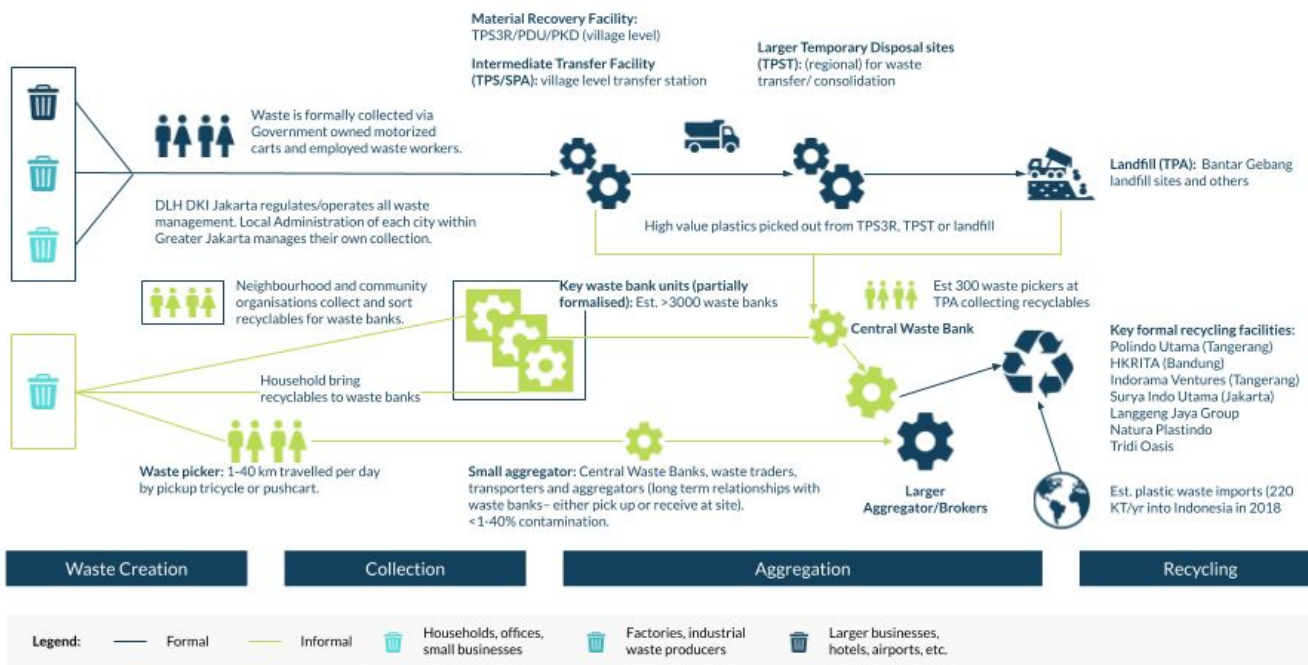


Figure 8: The plastic waste supply chain in Greater Jakarta.



²² Polymer split of informal collections are based on sample interviews undertaken for this project and might underestimate the amount of PE films being collected.

²³ 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.

Insights on local plastic recycling supply chains in Makassar

An estimated 17% or 10 KT/yr of plastic collected from MSW is being recycled in Makassar, one of the major waste producers in Eastern Indonesia, but a progressive wasteshed which promotes a digital system to connect Waste Banks and recyclers.

The plastics collected from MSW that is being recycled are mainly informally collected. 74% of plastic is collected via formal MSW collection, with the majority of this plastic waste being sent to landfills (98%), and 2% collected by the informal sector from landfill sites.

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 site 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 TPSTs at the regional level handle waste transfers and consolidation.

Formally collected municipal waste is mainly transported to the Tamangapa landfill outside the city, where informal collectors pick recyclables from the landfill site. Some TPS and TPS 3R sites receive materials prior to being sent to landfill.

An estimated 200-300 Waste Bank units form part of the Makassar Waste Bank program. 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 then buys the waste from the Waste Bank units before selling the plastics to a private aggregator.

In an effort to digitalize the Waste Banks and improve transparency, the Municipal Government of Makassar has a memorandum of understanding with PT Daur Ulang Industri Terpadu to develop a waste distribution app, 'Octopus'. The app standardizes the types, condition, and weight of non-organic waste and provides an IT-based, transparent, and accountable Waste Bank management system. The introduction of a digital system to connect producers of plastic waste with waste collectors, Waste Banks and recyclers, as well as involving registered and verified informal waste pickers, is a stepping stone to create a more transparent market.

Key recyclers are located near the Kima Industrial Plant. Others are active in Ambon (Maluku) and collaborate with recyclers from Makassar by combining their plastic flakes or granules to have sufficient volumes for export. Recycling overall is still low as the majority of plastic is being formally collected for transfer to landfills with very limited sorting and extraction.



Figure 9: Flow of plastic within municipal solid waste in Makassar (thousand tonnes per year.^{24,25} 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.

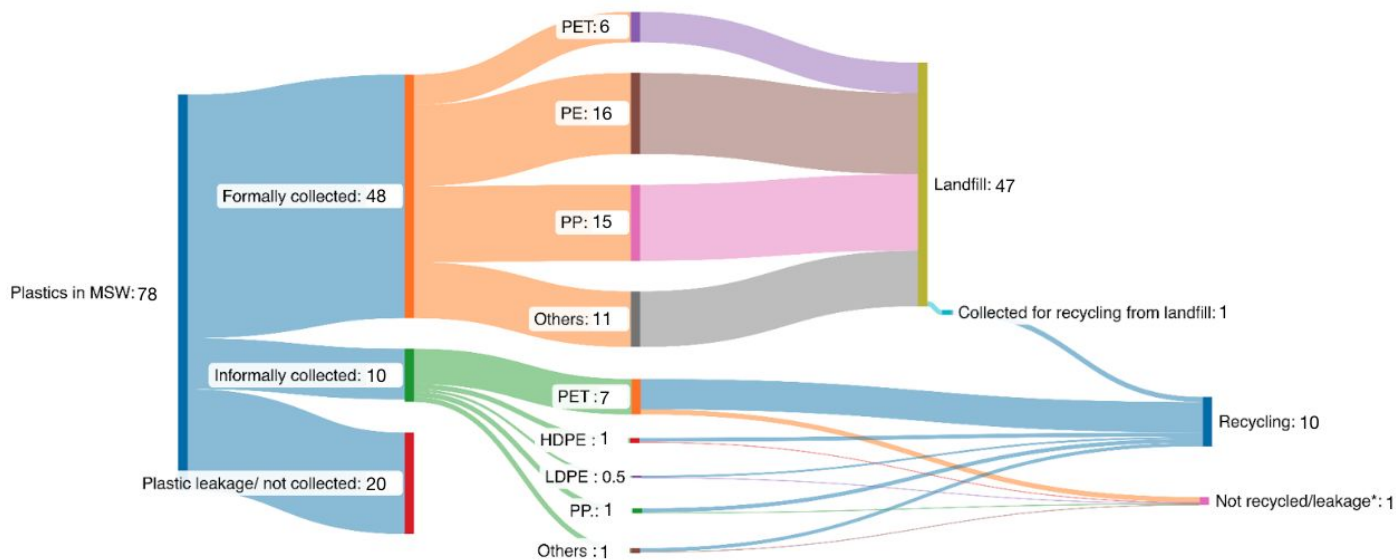
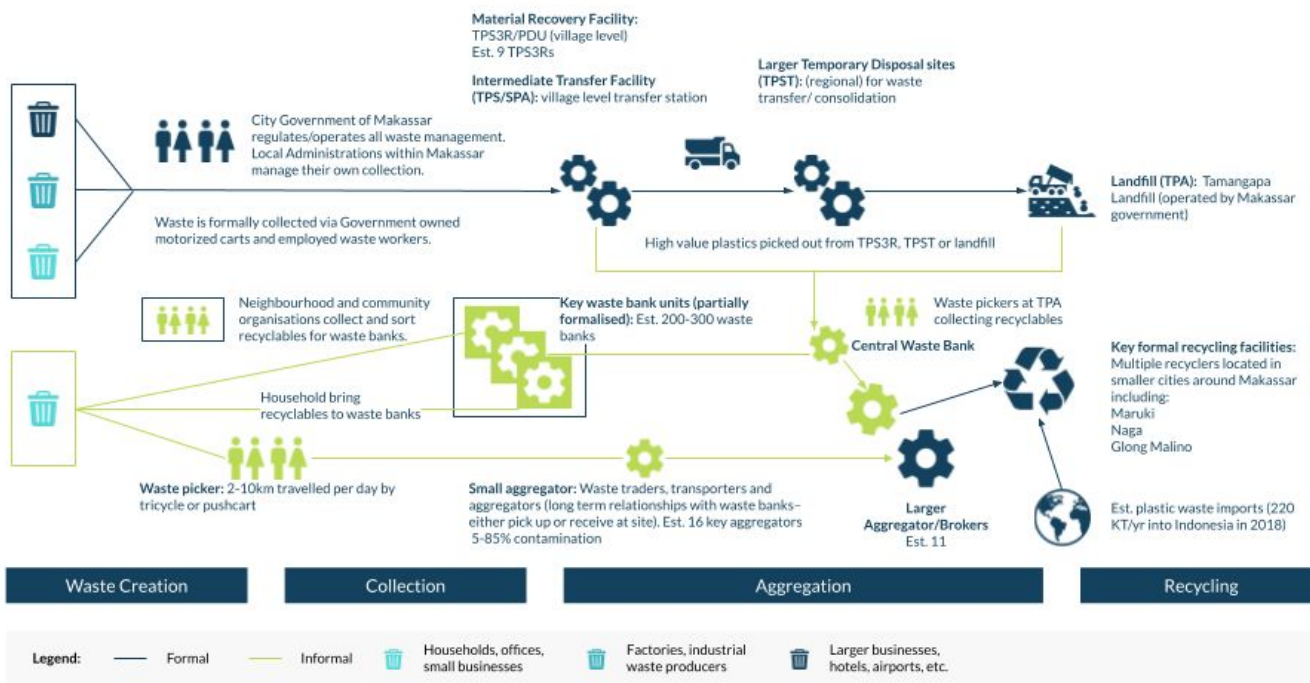


Figure 10: The plastic waste supply chain in Makassar.



²⁴ Polymer split of informal collections is based on sample interviews undertaken for this project and might underestimate the amount of PE films being collected.

²⁵ 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.

Insights on local plastic recycling supply chains in Surabaya

An estimated 15% or 13 KT/yr of plastics collected from MSW is recycled in Surabaya, mainly through the collection efforts of informal waste pickers. Surabaya has seen significant developments in community waste management and local waste infrastructure over the past two decades.

Recycling rates for plastic collected from MSW are slightly lower in Surabaya than in Makassar and Greater Jakarta. Aside from the plastic collected by the informal waste pickers, which mostly goes to recycling, 80% of plastic is collected by the formal sector, but the majority of this is disposed of in landfills.

The Surabaya Municipal Government regulates waste management in Surabaya, and the Green Space 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/RW²⁶). In comparison to many other areas in Indonesia, Surabaya has been developing strong and innovative systems for managing waste. For example, the public can make fare payments for city buses using plastic bottles with a reported 16,000 'plastic passengers' per week.²⁷

There are over 200 Waste Banks in the region, as well as a centralized 'Master' Bank, which is part of the Waste Community Accelerator program²⁸ that works with Griya Luhu, a digital Waste Bank platform provider based in Bali.

Of the estimated 190 TPS sites in Surabaya, nine are TPS 3Rs.²⁹ Seven key aggregators supply material to different recyclers, depending on the polymer. There are multiple recyclers in the smaller cities around Surabaya. Formalized recycling infrastructure consists of medium- to large-scale recyclers for PET and PP, as well as for recycling of PE flexibles.

Surabaya has a well-established network of Waste Banks, TPS 3R, and TPA sites, and the first WtE plant in Indonesia. In 2019, it was awarded Adipura Kencana, the highest clean city award to recognize its progress.³⁰ However, despite the available infrastructure and some regional regulation, recycling rates for plastic are low, which suggests that sorting predominantly still takes place at Waste Banks and via informal collection/waste picking on a limited scale.



²⁶ RT stands for Rukun Tetangga or Neighbourhood Unit, while RW stands for Rukun Warga or Community Unit.
²⁷ United Nations – Closing the Loop on Plastic Waste in South East Asia: Surabaya City Profile (2020).
²⁸ Ocean Plastic Prevention Accelerator (OPPA) – Waste Community Accelerator (2022).
²⁹ Repjogja – Nine TPS in Surabaya Have Implemented the 3R Concept (2021).
³⁰ Pace Circular - A Financing Roadmap Developed by the Indonesia National Plastic Action Partnership (2020).

Figure 11: Flow of plastic within municipal solid waste in Surabaya (thousand tonnes per year).^{31,32} 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.

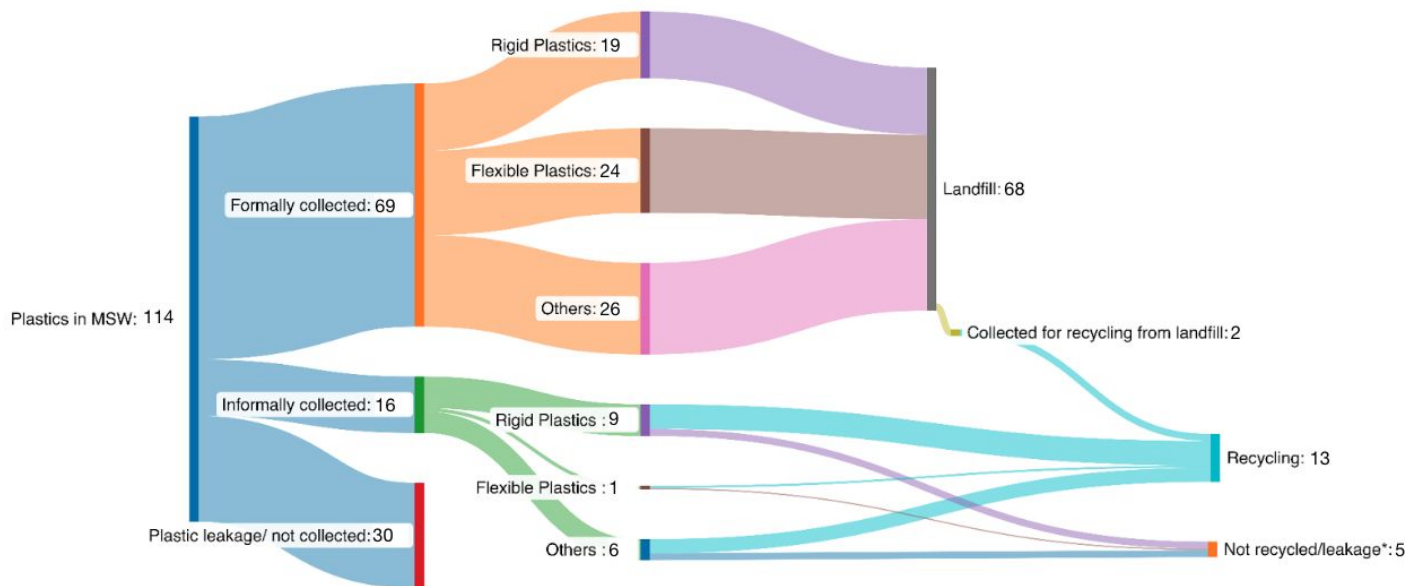
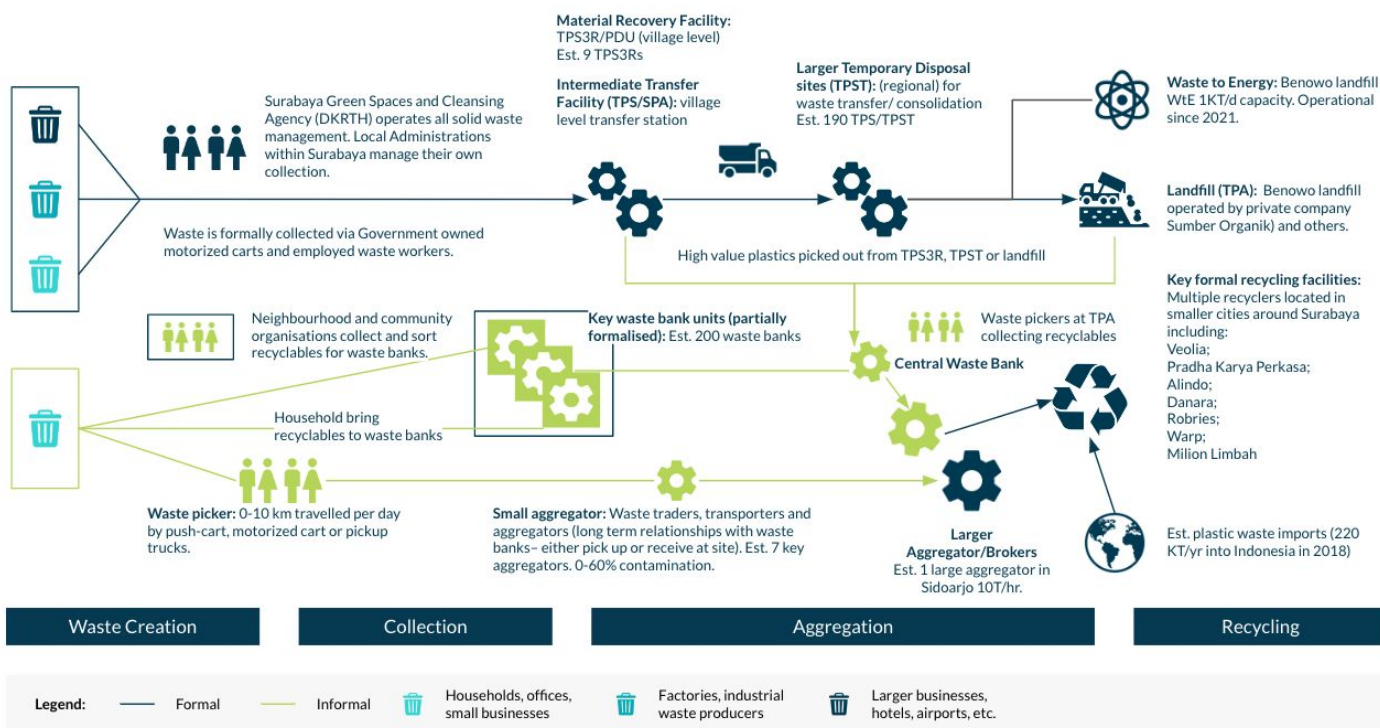


Figure 12: The plastic waste supply chain in Surabaya.



³¹ Polymer split of informal collections is based on sample interviews undertaken for this project and might underestimate the amount of PE films being collected.

³² 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.

The need for intervention

Recognizing the gaps that are limiting the effectiveness of existing local plastic waste recycling supply chains across the wastesheds, the following outlines the challenges and the interventions that could be considered to improve collection rates, increase sorting and segregation of plastics for recycling and enable growth in plastics recycling for a circular economy in Greater Jakarta, Surabaya and Makassar. The interventions summarized below are aimed at governments and industry and are identified to be generally similar across wastesheds, given the common challenges faced in terms of infrastructure gaps, fragmented supply chains and limited enforcement of regulations.



Mapping local plastic recycling supply chains: Summary Insights from Thailand



In Thailand, uncollected plastic waste and unsanitary disposal facilities result in an estimated 428 KT/yr of mismanaged plastic waste.³³ However, the country is on a good trajectory to having stronger local plastic waste supply chains in future, with an established and growing national reprocessing infrastructure operated by local and international players.

A comparison between the three wastesheds, Bangkok, Chon Buri, and Rayong, shows that the market structure for reprocessing is strong, with multiple companies having developed formal treatment capacity for recycling. However, all wastesheds still rely on the informal sector for collection of recyclables. Plastic waste is not routinely separated at source, which contributes to low collection rates, with Bangkok estimated to have only a marginally higher rate than Chon Buri and Rayong.

Interventions aimed at improving collection rates, increasing sorting and segregation of plastics for recycling, and enabling growth in plastics recycling for a circular economy will contribute to scaling up the supply chains in all three wastesheds.

The detailed insights are provided in the report, [Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Thailand](#).

³³ World Bank - *Plastic Waste Material Flow Analysis for Thailand (2022)*.

Insights on local plastic recycling supply chains in Bangkok

An estimated 15% or 134 KT/yr of plastics collected in MSW is being recycled in Bangkok, with the informal sector collecting more than 90% of the plastic going to recycling, and a large number of formal recyclers being located close to Bangkok, with key facilities in nearby provinces.

The Bangkok Metropolitan Administration (BMA) leads waste collection and has short-term (one to four years) and longer-term (up to 10 years) contracts with private formal waste management providers delivering transfer, landfill disposal, RDF production and WtE services. The BMA has started educating households to increase segregation of recyclables at source; however, this is still at a very early stage.

The majority of municipally-collected waste is sent to landfills in neighboring provinces. A small amount of waste is currently sent to WtE facilities, though this is expected to grow in future with the development of two new sites. These are due to become operational in 2024 and will each treat around 1,000 tonnes of waste as fuel each day.³⁴

Newer trucks used by BMA to collect municipal waste have a section for recyclable material. However, anecdotal feedback from local supply chain actors suggests that the material collected is not separately managed through a formal system, but is traded with informal workers at the transfer station, entering the informal system for aggregation and recycling.

BMA is no longer issuing new commercial and environmental permits for any new aggregators in Bangkok with the aim to reduce the number of junk shops. Space in the capital city is limited and comes at a price, so land area has been prioritized to be utilized for housing or commercial activities other than for waste management related functions.

There are a large number of formal recyclers located close to Bangkok, with key facilities in nearby provinces, including Indorama Ventures (a PET recycling facility), PDMT Group (processing both mixed rigid and flexible plastics), and Suez (a PET recycling facility that will process LDPE in the future).

Increased collection of PE films will need to be driven by demand from the recycling sector to make it a worthwhile waste format to collect. There have been trials to collect post-consumer PE films and pouches in the past; however, these have been abandoned as the recycling facility was not built. Aggregators stated that it takes time to build up new supply chains and they would require long-term commitments from recyclers before starting to handle PE films.



³⁴ National News Bureau of Thailand - MEA to construct waste-to-energy plants in Bangkok (2021).

Figure 13: Flow of plastic within municipal solid waste in Bangkok (thousand tonnes per year). 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.

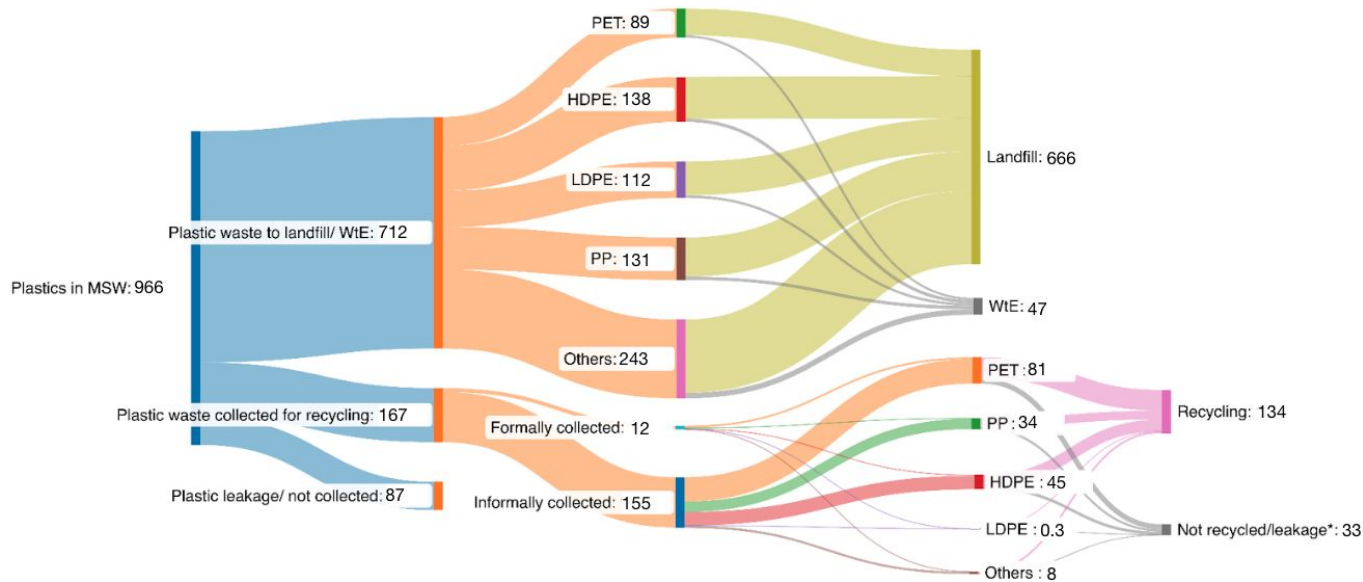
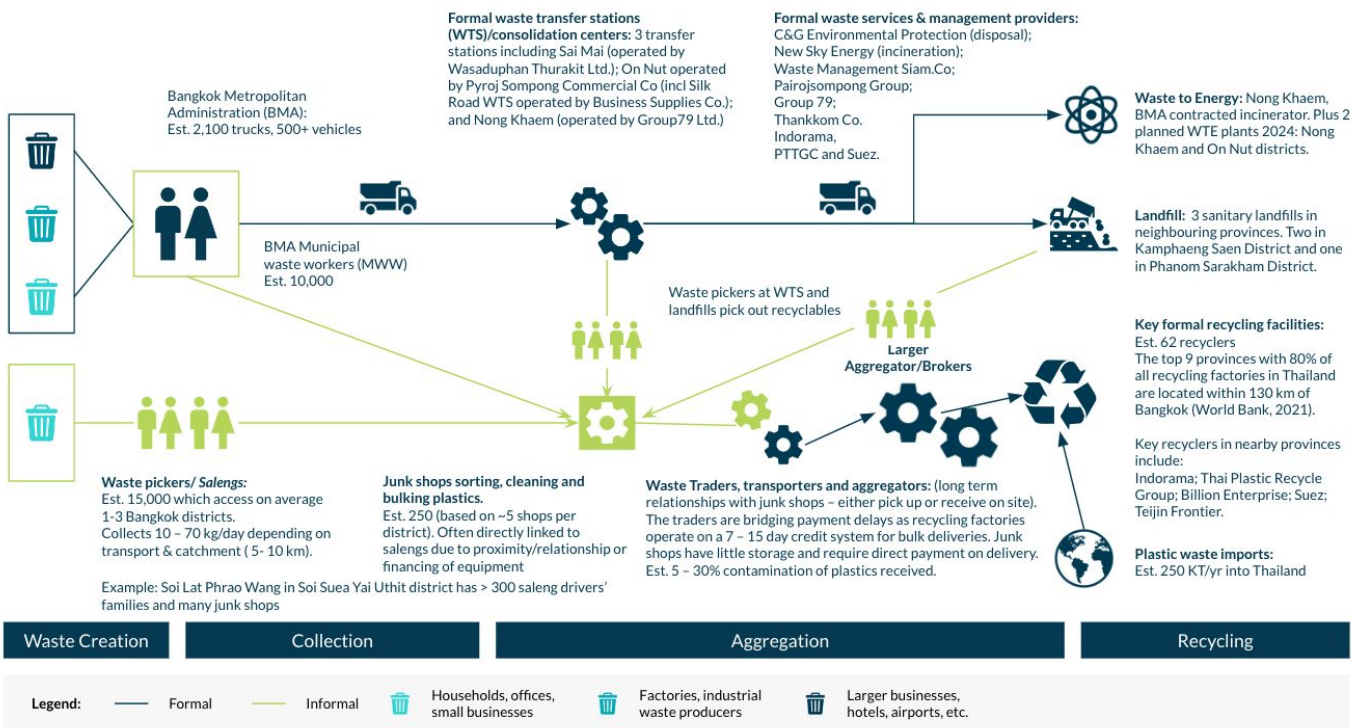


Figure 14: The plastic waste supply chain in Bangkok.



Insights on local plastic recycling supply chains in Chon Buri

An estimated 14% or 27 KT/yr of plastics collected in MSW are recycled in Chon Buri, which has many aggregators, resulting in competition for material.

The Chonburi Provincial Administrative Organization undertakes collections of municipal waste. Formal aggregation is undertaken by contracted companies, such as Suez and Waste Management Siam Co, which are responsible for transporting waste to one of the four local landfill sites. It is estimated that around 100 KT/yr is currently sent to WtE, with a key local site being Chonburi Clean Energy.

There are many aggregators in Chon Buri, which results in competition for material. Collectors find out which junk shops have the highest daily prices and challenge the price with their local aggregators. Wongpanit Group, one of Thailand's largest waste aggregation facilities, has facilities in Chon Buri and Phitsanulok, as well as franchisees in most large cities in Thailand. Wongpanit's material prices are reported nationally and influence the price set by smaller aggregators across the country. The franchise model is free of charge to enter and attempts to promote best practice across the country to enable access to fairer pay and improved working conditions and security.³⁵

Waste from larger aggregators then goes to recyclers. Key formal recycling facilities in Chon Buri include Zing Whor Thai (processes rigid PET, HDPE and PP, and flexible materials), and Angtai (a PET bottle recycling facility).

Overall, Chon Buri's plastic recycling supply chain relies on the informal sector. As the main aggregator, Wongpanit's model has made a positive impact on plastics recycling in involving the informal workers, but the local administration lags behind Bangkok and Rayong in promoting source segregation or working in public/private partnerships to increase recycling across the city and province.



³⁵ Interviews with local value chain participants, October 2022.

Figure 15: Flow of plastic within municipal solid waste in Chon Buri (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. *'Not recycled/leakaged' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.

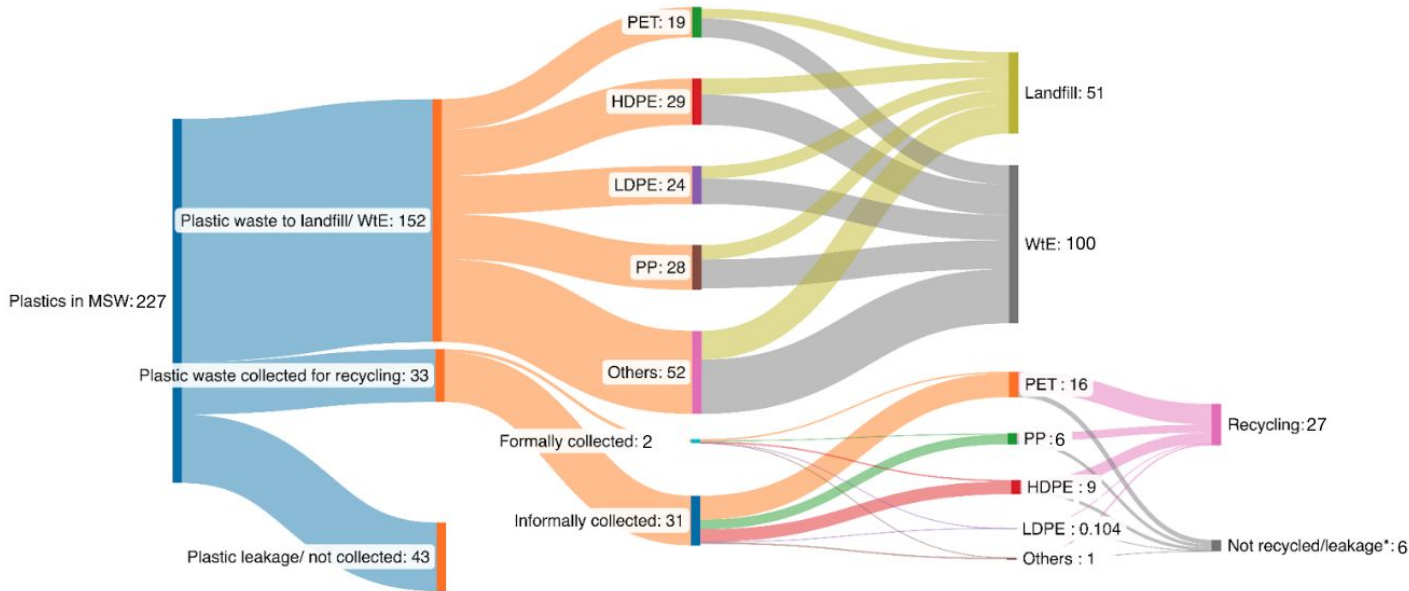
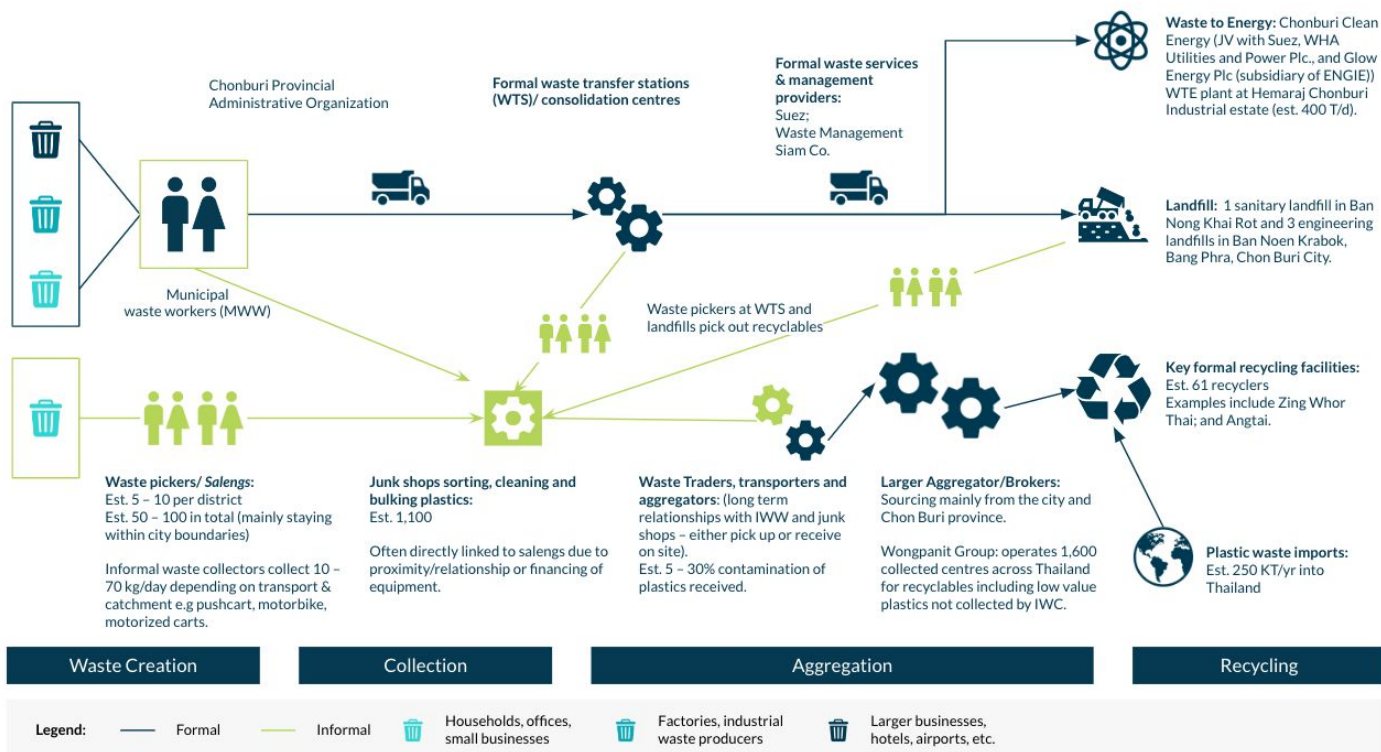


Figure 16: The plastic waste supply chain in Chon Buri.



Insights on local plastic recycling supply chains in Rayong

An estimated 14% or 7 KT/yr of plastic waste collected in MSW is recycled in Rayong, with the informal sector underpinning the collection and aggregation of plastic waste for recycling, and the Rayong model promoting source segregation of plastics in the city.

The Rayong Provincial Administration Organization is responsible for the organization of waste management in Rayong, acting as the collection operator. After waste is collected, it is aggregated at transfer stations and transported to one of two landfill sites in Khao Bot Village and Phra Samut Chedi. A small amount of waste is sent to a joint-venture WtE facility located next to the Integrated Solid Waste Disposal Center in Rayong, which has a sorting unit to help convert waste into refuse-derived fuel for use in cement kilns.³⁶

The informal sector contributes significantly to the collection and aggregation of plastic waste for recycling in Rayong. The plastic waste collected by the informal waste collectors (salengs) goes to the junk shops based on proximity or established relationships. The waste then goes to aggregators, which may also have long-term relationships with the informal waste collectors and junk shops, followed by larger aggregators before going to recyclers. Key formal recycling facilities in Rayong include SCG Chemicals; Polyplex Thailand's EcoBlue plant; and ALPLA and PTT Global Chemical's ENVICCO facility.

There are efforts to increase plastic waste that is formally collected for recycling through the 'Rayong model'. The 'Rayong model' promotes source segregation of plastics in premises such as homes, offices, and schools via a private/public partnership approach. Following its successful implementation in 2018/19, the model is now being extended to schools, shopping centers and large supermarkets in Rayong.³⁷

However, the amounts collected through the model are still very small (about 480-540 T/yr) and have not reached the target of 10% of plastics recycled (or 900 tonnes a month). Ideally, additional separation needs to take place to extract valuable plastics from mixed waste. Some sorting has started at the new WtE/RDF plant; currently, however, films and many other plastics are left in the RDF to achieve the required energy content for the cement industry.



³⁶ GPSC – Pracharat helps manage waste management in sustainable ways Rayong Province (2018).

³⁷ Energy News Center – Tackling plastic waste with the "Rayong Model" (2019).

Figure 17: Flow of plastic within municipal solid waste in Rayong (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. *'Not recycled/leakaged' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.

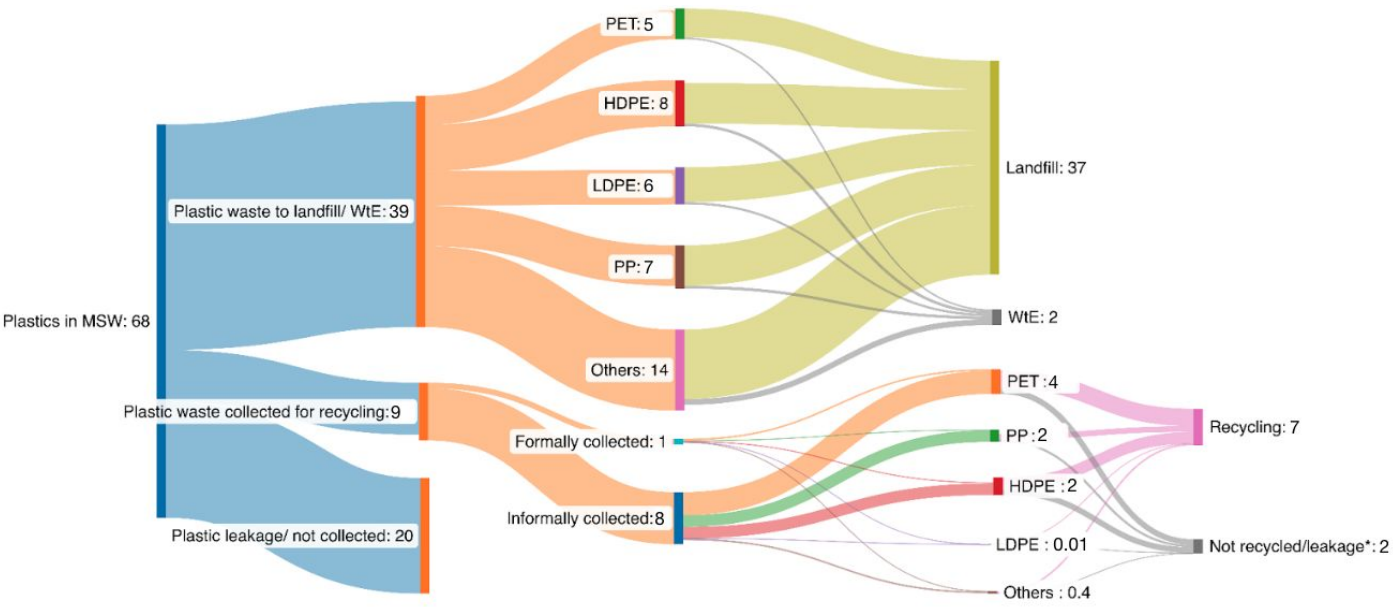
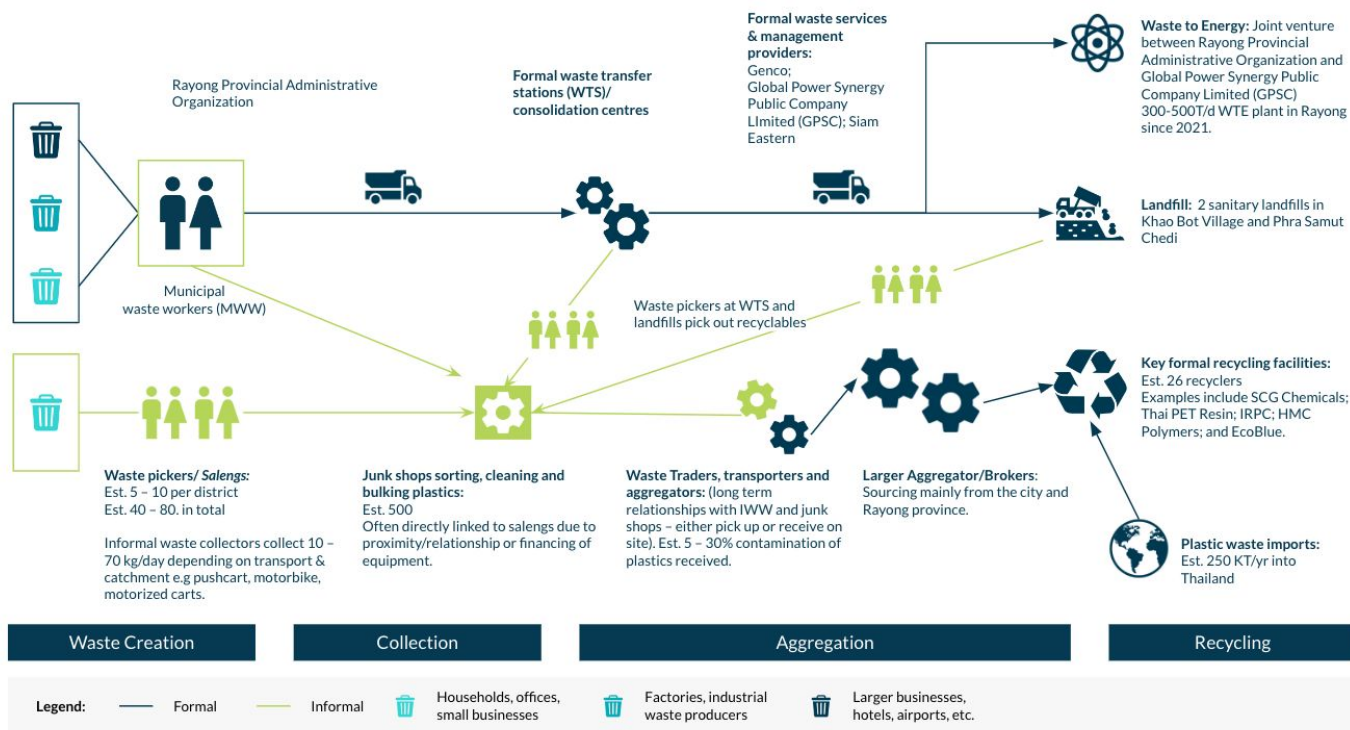


Figure 18: The plastic waste supply chain in Rayong.



The need for intervention

Recognizing the gaps that are limiting the effectiveness of existing local plastic waste recycling supply chains across the wastesheds, the following outlines the challenges and the interventions that could be considered to improve collection rates, increase sorting and segregation of plastics for recycling and enable growth in plastics recycling for a circular economy in Bangkok, Chon Buri and Rayong. The interventions summarized below are aimed at governments and industry and are identified to be generally similar across wastesheds, given the common challenges faced in terms of infrastructure gaps, fragmented supply chains and limited enforcement of regulations.



Mapping local plastic recycling supply chains: Summary Insights from Viet Nam



Across the three wastesheds, Hanoi, Ho Chi Minh City, and Da Nang, supply chains are very similar due to the strong role of the national and local governments in the waste management sector, with limited contracting and involvement of the private sector.

Ho Chi Minh City, Viet Nam's largest city, has the most established and best performing local supply chain for plastic waste, followed by Hanoi, the region's capital. Though some plastic collection is present, the supply chain in Da Nang requires the greatest support to develop and scale up in future.

Viet Nam has considerable opportunity to reduce its reliance on plastic imports and increase recycling through improving domestic supply chains for secondary plastic derived from waste. While EPR and other national initiatives have also been announced to further improve plastics recycling, implementation timeframes and measures are outstanding.

The detailed insights are provided in the report, [Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in Viet Nam](#).

Insights on local plastic recycling supply chains in Hanoi

An estimated 20% or 108 KT of plastics collected in Hanoi goes to recycling, with informal recyclers dominating the supply chain in terms of plastics processed and recycled.

Hanoi has a good level of waste collection, with an estimated 90% of MSW being collected and a long-established informal supply chain. The plastics collected for recycling are mainly collected by the informal sector. Plastics collected through the formal supply chain do not undergo further separation or sorting, and though municipal waste collectors may extract some valuable materials from their collection routes and trade them through the informal sector for additional income, the amounts traded onto the informal sector are anticipated to be small.

While some private operators exist in the region, collection of MSW is dominated by public waste management provider, the Hanoi Urban Environment Company (URENCO). After collection, waste is brought to either of three transfer/consolidation centers at key landfill sites in Hanoi. No separation or sorting takes place at these centers.

Most formal and informal recyclers are located in provinces outside Hanoi. While more formal recycling facilities have been announced, craft villages³⁸ and informal recyclers currently dominate the supply chain in terms of plastics processed and recycled. Only rigid plastics (PET, HDPE and some PP) are being collected informally, while some additional rigid plastics are being retrieved from major landfills. Where LDPE/flexibles are being collected, these are not accepted by traders due to low value and the lack of end markets. The limited number of medium- to large-scale recyclers, low recycling rate of collected plastics and lack of recycling flexibles leads to considerable value loss (with value yields³⁹ of 16% for PET, 34% for HDPE, and 0% for LDPE and PP).

The central government has adjusted national legislation to improve recycling and the recovery of waste. Operating within this strong national regulatory framework, URENCO has launched a small trial to encourage the public to segregate their recyclables; however, this is not city-wide and further work is needed to fully implement national policy. In addition, four new WtE plants have been announced to lessen Hanoi's reliance on landfills.



³⁸ Craft villages refer to villages in which many households are involved in informal waste collection, aggregation, pre-processing and even some recycling of tradable waste. They also sometimes process imported waste and larger craft villages may trade directly with formal recyclers.

³⁹ Value yield refers to the value of recycled plastics using recyclate pricing vs. the value of plastics collected using virgin prices.

Figure 19: Flow of plastic within municipal solid waste in Hanoi (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. The share of plastics collected in Hanoi is calculated based on an 91% MSW collection rate. *'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.

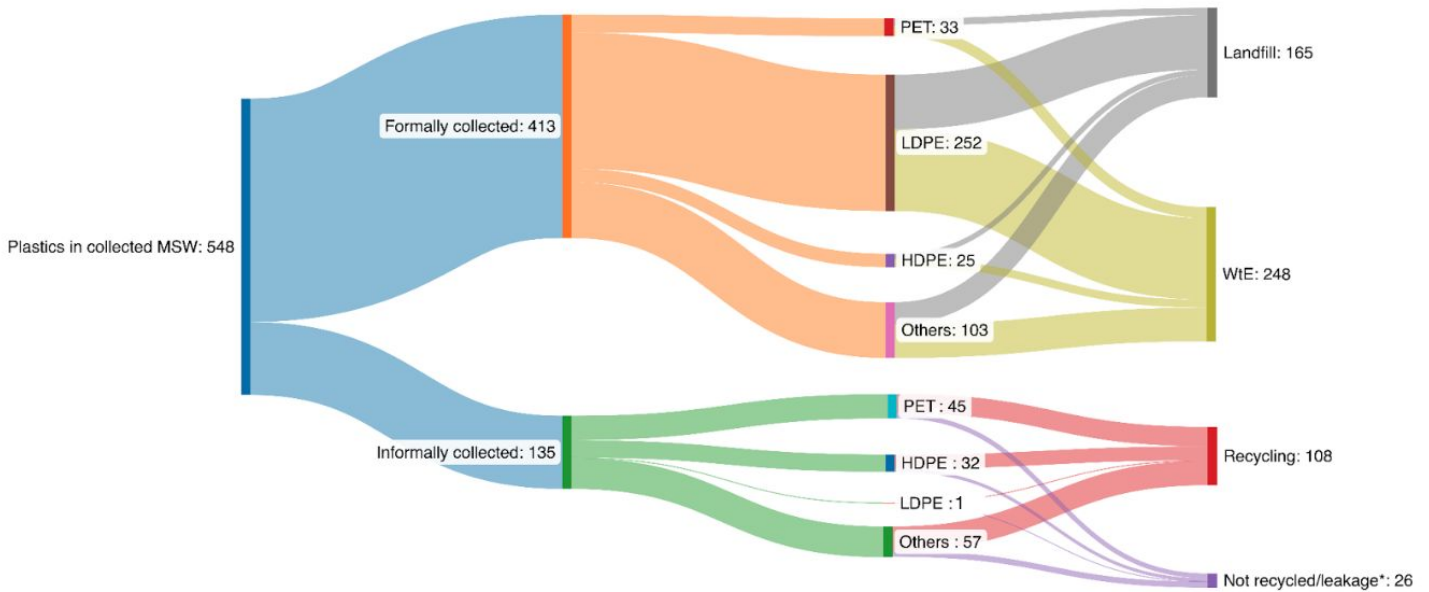
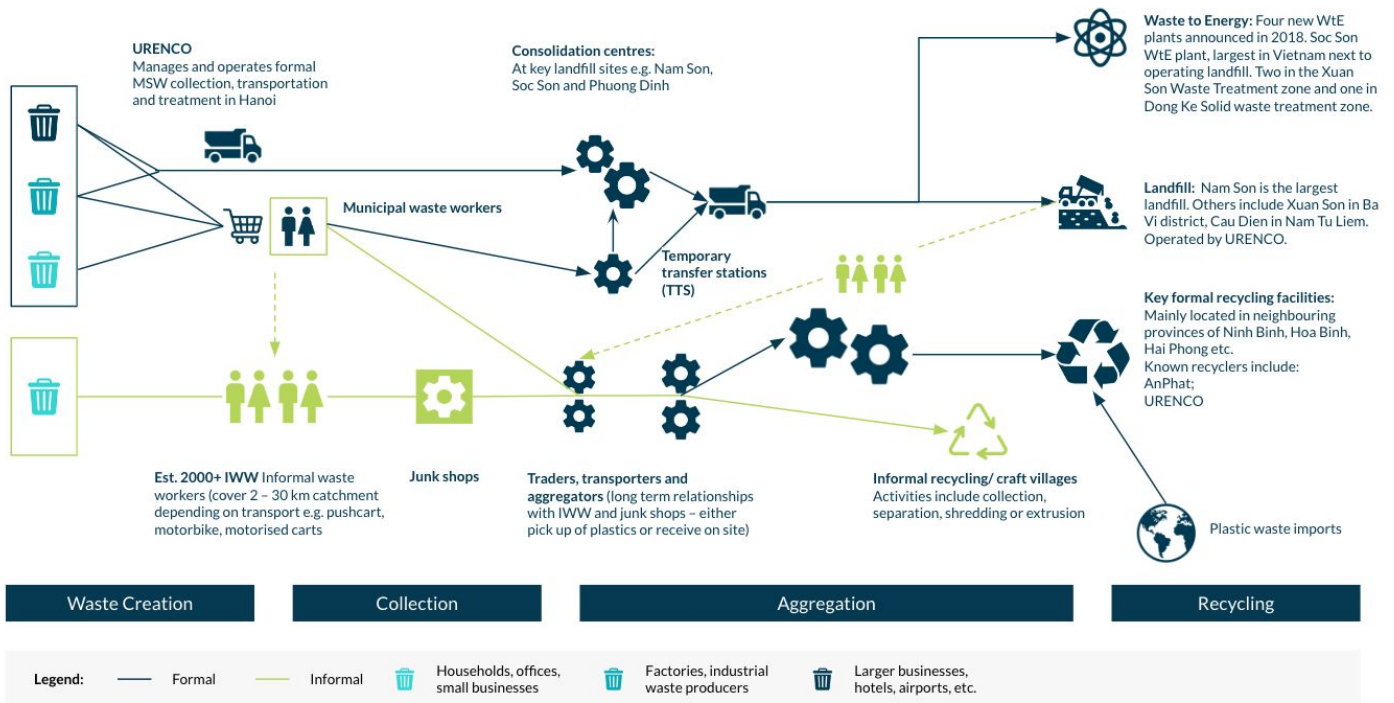


Figure 20: The plastic waste supply chain in Hanoi.



Insights on local plastic recycling supply chains in Ho Chi Minh City

An estimated 21% or 145 KT/yr of municipally-generated plastic waste is collected for recycling in Ho Chi Minh City, which, unique from the other wastesheds, has made progress in incorporating informal waste workers into formalized collections through licensing.

Ho Chi Minh City has started formalization of waste collectors through licensing, where independent waste collectors are appointed to collect from households and businesses that are difficult to access with vehicles. It is estimated that informal waste workers collect 65-70% of domestic waste from households. Sorted recyclables, like plastics, are sold through the informal network, while the rest of the waste is transferred to formal collection points.

Public waste manager, Ho Chi Minh City Environmental Company (CITENCO), dominates MSW collection with limited but growing competition from private waste companies. Several private waste collectors are contracted for collection in specific areas or the management of landfills. Collected material is then transferred via two large compression transfer stations, which are not designed to allow extraction for recycling. Landfill is the main disposal route currently, though by 2025 it is anticipated that the majority of MSW will be treated by WtE plants.

In the past, the city has explored the use of formalized sorting facilities and has, in principle, agreements with key private waste management companies to deliver single-stream recyclable materials for sorting. However, to date, arrangements have not been implemented and it is estimated that 98% of mixed waste collected is going to landfills. One of the biggest landfill operators for Ho Chi Minh City has stated that the waste that arrives at the landfill is mostly stripped of valuable material and therefore does not justify the investment cost of formal extraction or the related health and safety risks to informal workers if informal extraction is allowed.

While no sorting and separation takes place at Ho Chi Minh City's two key transfer/consolidation centers, there are current and planned activities for Moc An Chau, an area dedicated to the city's waste management activities, including recycling and organic waste treatment.

Most segregation and processing is currently undertaken by informal recyclers and craft villages. There are a small number of formal recyclers within the boundaries of the city, and there are around 70 informal plastic recycling facilities in District 11. No new licenses and permits are being issued as a strategy to move operations outside of the central business district to the outskirts or surrounding areas.

While the city is making efforts to integrate the informal sector and expand the formal sorting, aggregation and recycling infrastructure, progress has been slow and some ventures had to be abandoned due to technical and management constraints impacting the implementation of new treatment facilities.



Figure 21: Flow of plastic within municipal solid waste in Ho Chi Minh City (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. Formal MSW collection figures include the contribution of permitted informal waste collectors, but their contribution to plastic recycling is captured in the informal recycling trade flow. The share of plastics collected in Ho Chi Minh City is calculated based on an 91% MSW collection rate. *'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.

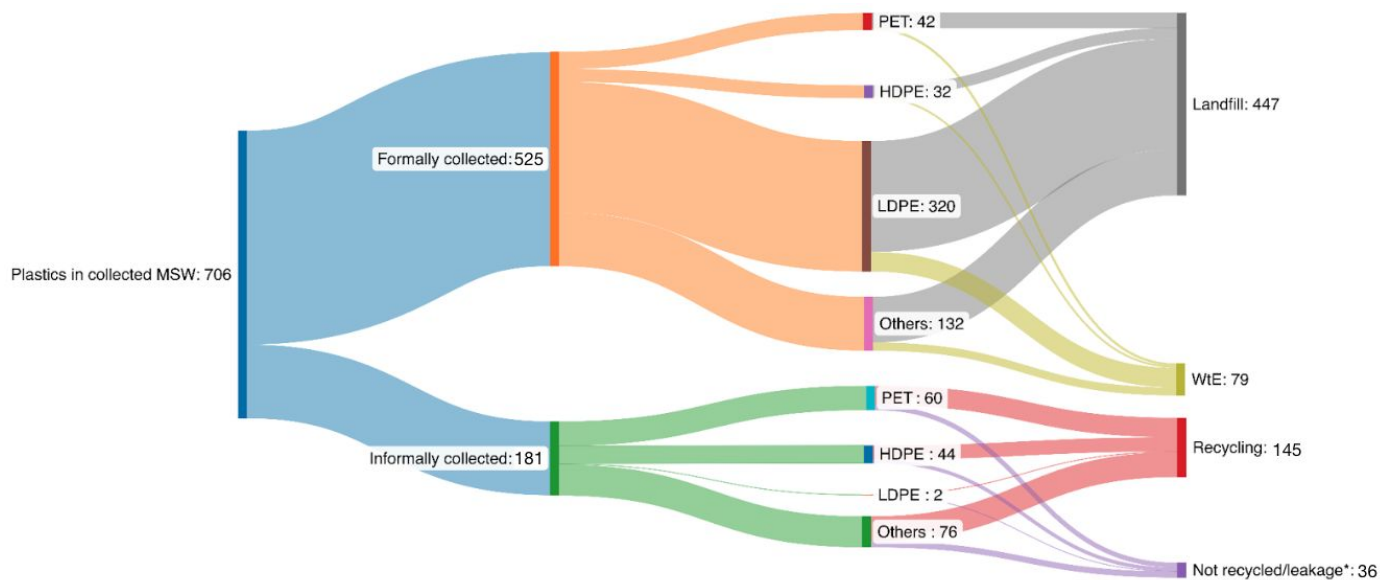
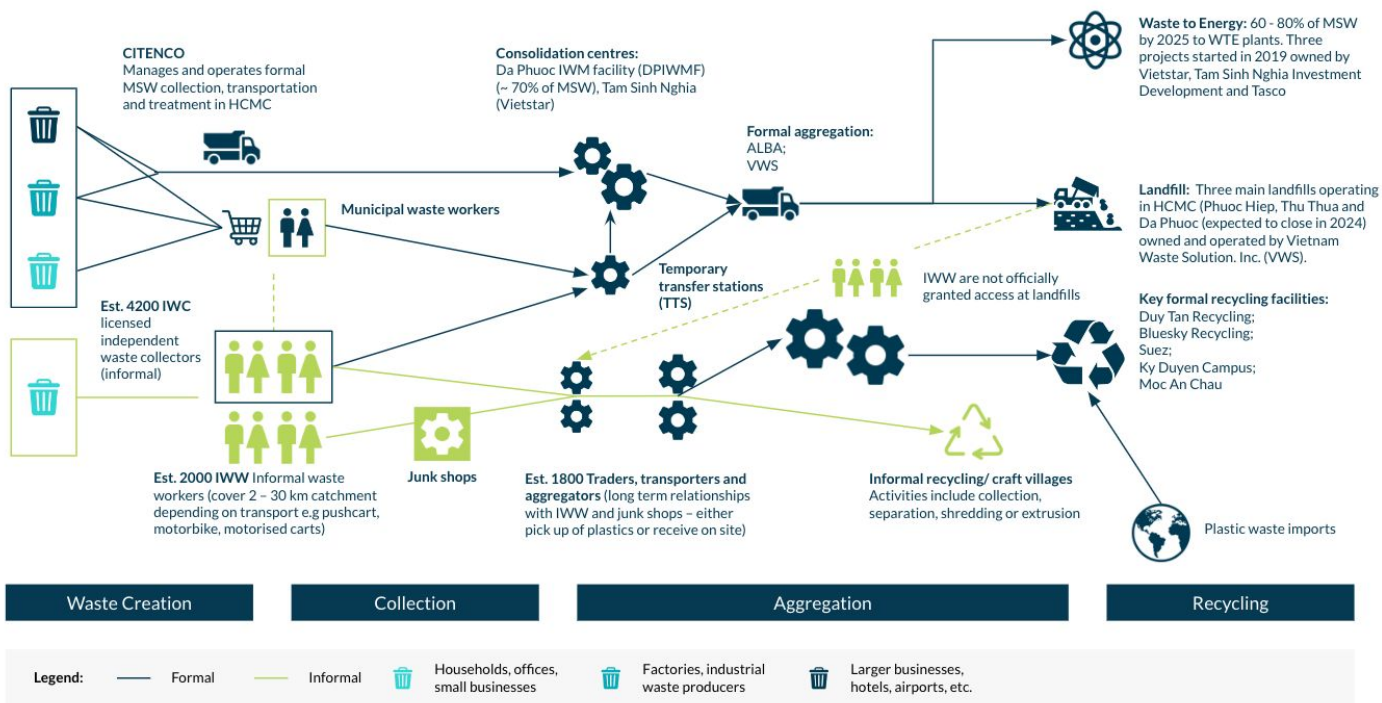


Figure 22: The plastic waste supply chain in Ho Chi Minh City.



Insights on local plastic recycling supply chains in Da Nang

An estimated 20% or 17 KT of municipally-generated plastic waste is collected for recycling in Da Nang, where there are no known permitted plastic recyclers. Recycling takes place in informal craft villages or materials are transported outside the city.

Public waste manager, the Da Nang Urban Environment Company (DNURENCO), dominates MSW collection, with limited but growing competition from private waste companies. Collection in some wards is undertaken by URENCO Hanoi.

There is currently no sorting or separation at the five key transfer/consolidation centers. This is mostly undertaken at informal traders and craft villages. While Da Nang recently opened its first compression container transfer station, this site does not have a dedicated process for the extraction of recyclables.

There is a lack of formal recycling infrastructure in Da Nang, with plastic waste being transported to Ho Chi Minh City, Hanoi or other areas for recycling. Recycling is mainly done by informal workers, mostly in craft villages. While the city does not issue any permits for collection centers, it does not currently actively interfere in the informal collection system and allows, for example, informal picking at landfills. Observations of landfilled material indicate that significant amounts of tradable recyclable material are being disposed of, which could otherwise be feedstock for recycling.

In an effort to scale up its plastic waste recycling supply chain, the city has announced plans to implement a new household recycling scheme and has set a 15% MSW recycling rate target for 2025. A new WtE facility is under construction, and the fast-growing city is considering further alternatives to landfills. However, although local recycling targets have been set, there has not yet been widespread change to implement key national framework legislation locally. The city is a growing hub of industrial activity and will need to scale up its plastic waste recycling supply chain to ensure higher levels of segregation and recycling.

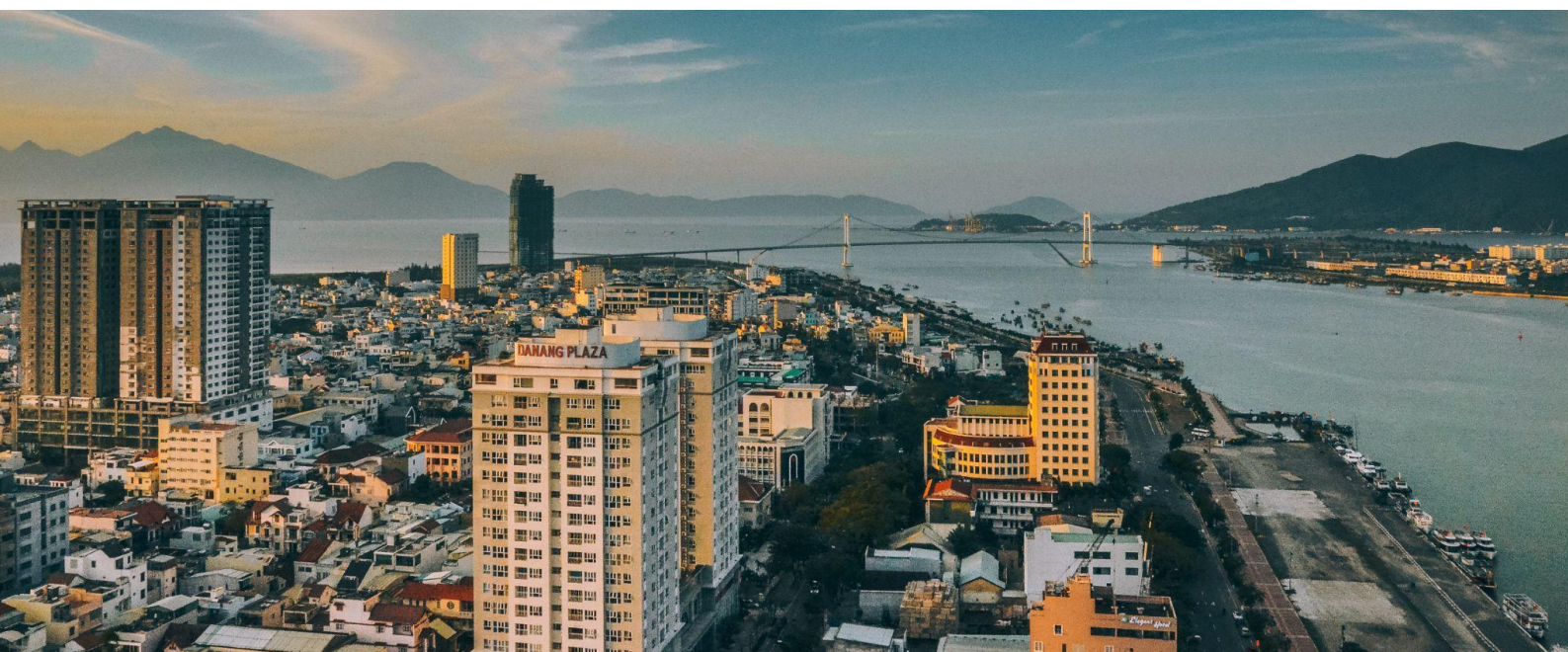


Figure 23: Flow of plastic within municipal solid waste in Da Nang (thousand tonnes per year). Figures are rounded to the nearest whole number and may not sum because of rounding. The share of plastics collected in Da Nang is calculated based on an 91% MSW collection rate. *'Not recycled/leakage' refers to plastic waste collected, but not recycled due to contamination or the collectors being unable to sell low-value plastics to aggregators.

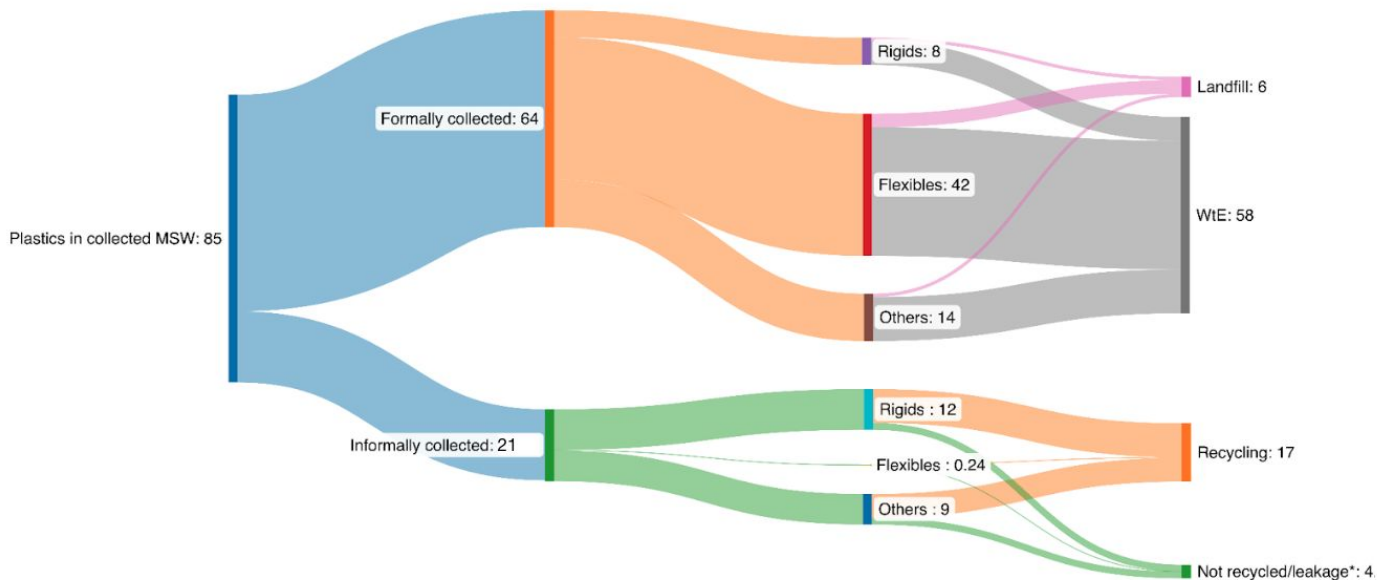
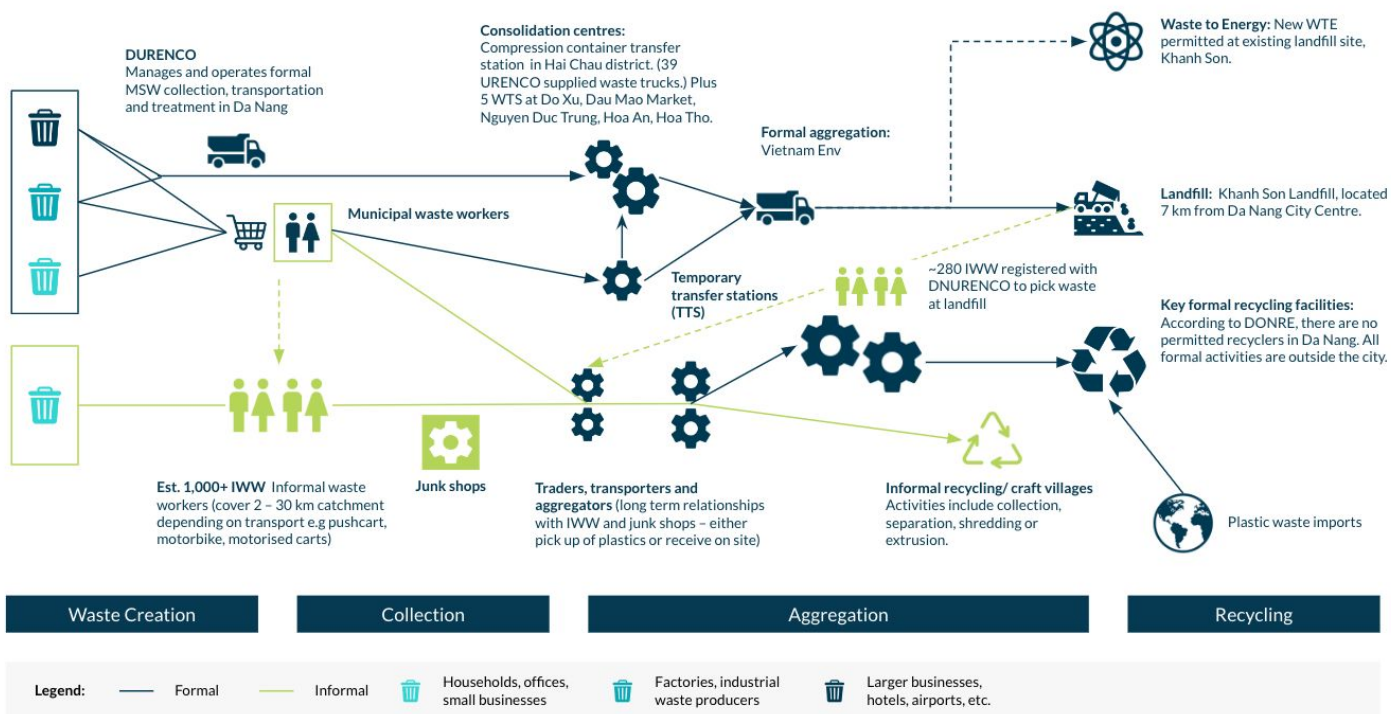


Figure 24: The plastic waste supply chain in Da Nang.



The need for intervention

Recognizing the gaps that are limiting the effectiveness of existing local plastic waste recycling supply chains across the wastesheds, the following outlines the challenges and the interventions that could be considered to improve collection rates, increase sorting and segregation of plastics for recycling and enable growth in plastics recycling for a circular economy in Hanoi, Ho Chi Minh City and Da Nang. The interventions summarized below are aimed at governments and industry and are identified to be generally similar across wastesheds, given the common challenges faced in terms of infrastructure gaps, fragmented supply chains and limited enforcement of regulations.



References

Delhi Pollution Control Committee. (2021). *Annual Report for the Year 2020-2021* [Online]. Available at: <https://www.dpcc.delhigovt.nic.in/uploads/pdf/PMWAnnualReport2020-21pdf-0ee6d3448355f608c9d5d4d2a81292d2.pdf> (Accessed: October 2022).

Ekuatorial. (2022). *Waste banks, one of the solutions in waste management* [Online]. Available at: <https://www.ekuatorial.com/en/2022/05/waste-bank-s-one-of-the-solutions-in-waste-management/> (Accessed: October 2022).

Energy News Centre. (2019). *Tackling plastic waste with the Rayong model*. [Online] <https://www.energynewscenter.com/tackling-plastic-waste-with-the-rayong-model/> (Accessed: October 2022).

GPSC. (2018). *Pracharat helps manage waste management in sustainable ways Rayong Province* [Online]. Available at: www.gpscgroup.com/en/investor-relations/newsroom/press-releases/668277/pracharat-helps-manage-waste-management-in-sustainable-ways-rayong-province-rayong-provincial-administration-have-joined-hand-with-gpsc-to-create-comprehensive-waste-management-strategy-with-refuse-derived-fuel-rdf-technology (Accessed: October 2022).

Greater Chennai Corporation. (2022). *Solid Waste Management* [Online]. Available at: <https://chennaicorporation.gov.in/gcc/department/solid-waste-management/> (Accessed: October 2022).

Hasiru Dala. (2018). *What is the mainstream waste system* [Online]. Available at: <https://hasirudala.in/about/waste-ecosystem/> (Accessed: October 2022).

Indonesia National Plastic Action Partnership. (2020). *Financing System Change to Radically Reduce Plastic Pollution in Indonesia: A Financing Roadmap Developed by the Indonesia National Plastic Action Partnership*. Available at: <https://pacecircular.org/sites/default/files/2021-03/NPAP-Indonesia-Financing-Roadmap%20%281%29.pdf> (Accessed: October 2022)

Indian Express. (2019). *Plastic ban: Most dairies in Maharashtra yet to start buying back and recycling of milk pouches* [Online]. Available at: <https://indianexpress.com/article/cities/mumbai/plastic-ban-most-dairies-maharashtra-yet-to-start-buying-back-and-recycling-of-milk-pouches-6043258/> (Accessed: October 2022).

International Alliance of Waste Pickers. (2014). *City Report: Interview with a local Waste Picker* [Online]. Available at: <https://globalrec.org/city/new-delhi/> (Accessed: October 2022).

Mid-day, Mumbai. (2022). *After bio-waste plant, Deonar waste-to-energy plant also spells trouble* [Online]. Available at: <https://www.mid-day.com/mumbai/mumbai-news/article/mumbai-after-bio-waste-plant-deonar-waste-to-energy-plant-also-spells-trouble-23248304#:~:text=Deonar%20receives%20around%20600%20metric.of%20electricity%20and%20incinerate%20waste.> (Accessed: October 2022).

National News Bureau of Thailand. (2021). *MEA to construct waste-to-energy plants in Bangkok* [Online]. Available at: https://thainews.prd.go.th/en/news/print_news/TCATG210323015013068 (Accessed: October 2022).

OPPA. (2022). *Waste Community Accelerator* [Online]. Available at: <https://www.oppa.id/waste-community-accelerator> (Accessed: October 2022).

Pace Circular. (2020). *Financing System Change to Radically Reduce Plastic Pollution in Indonesia: A Financing Roadmap Developed by the Indonesia National Plastic Action Partnership* [Online]. Available at: <https://pacecircular.org/sites/default/files/2021-03/NPAP-Indonesia-Financing-Roadmap%20%281%29.pdf> (Accessed: October 2022).

Repjogja. (2021). *Nine TPS in Surabaya Have Implemented the 3R Concept* [Online]. Available at: <https://repjogja.republika.co.id/berita/qu83mt327/sembilan-tps-sampah-di-surabaya-sudah-terapkan-konsept-3r> (Accessed: October 2022).

TERI. (2021). *Circular Economy for Plastics in India: A Roadmap* [Online]. Available at: <https://www.teriin.org/sites/default/files/2021-12/Circular-Economy-Plastics-India-Roadmap.pdf> (Accessed: October 2022).

The Hindu Business Line. (2021). *Ramky Enviro in 7-year waste management contract in Chennai* [Online]. Available at: <https://www.thehindubusinessline.com/news/national/ramky-enviro-in-7-year-waste-management-contract-in-chennai/article33916236.ece> (Accessed: October 2022).

Times of India. (2020). *Chennai's waste management to go hi-tech* [Online]. Available at: <https://timesofindia.indiatimes.com/city/chennai/chennai-waste-management-to-go-hi-tech/articleshow/78376635.cms> (Accessed: October 2022).

United Nations. (2020). *Closing the Loop on Plastic Waste in South East Asia: Surabaya City Profile* [Online]. Available at: <https://www.unescap.org/sites/default/d8files/Closing%20the%20Loop%20-%20Surabaya%20City%20Profile.pdf> (Accessed: October 2022).

Urbaser. (2020). *Urbaser Extends its International Presence with New Contracts in Asia and Latin America* [Online]. Available at: <https://www.urbaser.com/en/2020/11/urbaser-extends-its-international-presence-with-new-contracts-in-asia-and-latin-america/> (Accessed: October 2022).

World Bank. (2019). *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* [Online]. Available at: <https://documents1.worldbank.org/curated/en/608321575860426737/pdf/Indonesia-Improvement-of-Solid-Waste-Management-to-Support-Regional-and-Metropolitan-Cities-Project.pdf> (Accessed: November 2022).

Ministry of Environment, Forest and Climate, Change Government of India. (2022). *Centralized Extended Producers Responsibility Portal for Plastic Packaging* [Online]. Available at: https://eprplastic.cpcb.gov.in/#/plastic/home/main_dashboard (Accessed: October 2022).

Municipal Corporation of Delhi. (2022). [Online]. Available at: <https://mcdonline.nic.in/portal/?jsessionid=07D7129E89E3C5A48CDC7BC424C80F7A.sp> (Accessed: October 2022).

New Indian Express. (2022). *Pyrolysis plant to make oil and carbon from 20 tonnes of plastic a day* [Online]. Available at: <https://www.newindianexpress.com/cities/chennai/2022/jun/11/pyrolysis-plant-to-make-oil-and-carbon-from-20-tonnes-of-plastic-a-day-2464185.html> (Accessed: October 2022).

News Nine. (2022). *LG VK Saxena directed MCD to set up 24 material recovery facilities across Delhi within 6 months* [Online]. Available at: <https://www.news9live.com/state/delhi-ncr/lg-vk-saxena-directed-mcd-to-set-up-24-material-recovery-facilities-across-delhi-within-6-months-183108> (Accessed: October 2022).

Recykal. (2022). *Case study: a digital marketplace for quality material* [Online]. Available at: <https://recykal.com/recykal-library/> (Accessed: October 2022)

Shanker, R. et al. (2022). *Plastic waste recycling: existing Indian scenario and future opportunities* [Online]. Available at: <https://link.springer.com/article/10.1007/s13762-022-04079-x> (Accessed: October 2022).

TERI. (2022). *MSW Management: The pitiable situation of Municipal Solid Waste Management* [Online]. Available at: <https://www.teriin.org/article/msw-management-pitiable-situation-municipal-solid-waste-management#:~:text=Currently%2C%20as%20per%20government%20estimates,28%25%20is%20processed%20and%20treated> (Accessed: October 2022)

Acknowledgements

We would like to extend our sincere appreciation to the following organizations for their contributions to this publication.

LEAD RESEARCH PARTNER & CO-AUTHOR:



LOCAL RESEARCH PARTNERS:



Our gratitude also extends to all interviewees and peer reviewers for their involvement in this study. The following individuals provided support through interviews or critical reviews, and we also acknowledge several other contributors (waste collectors, waste pickers, aggregators, recyclers and other value chain stakeholders) who wish to remain unnamed:

- Aditya Dalmia, Dalmia Polypro
- Bobby Setiawan, PT Sumber Djaja Perkasa
- Chetan Baregar, Recykal
- Circulate Capital
- The Dow Chemical Company
- Dr. Shilpi Kapur Bakshi, Environmental Management Centre Pvt Ltd
- Hien Nguyen, ReForm Plastic
- Hong Tran, BMI Polymer JSC
- Kabir Arora, WIEGO
- Paradorn Chulajata, Prepack Thailand and Plastic Industry Club
- Phonsak Likithatsin, Thai Plastic Recycle Group Co Ltd
- Pimphan Chujam, Global Plasts Center Company Limited
- POPSEA
- Rahul Nainani, ReCircle
- Saharuddin Ridwan, Yayasan Peduli Negeri (YPN)
- Siddharth Hande and Toke Sabroe, Kabadiwalla Connect
- Suneel Pandey, The Energy and Resources Institute (TERI)
- Teerapat Yuanmee, PF Recycling
- Tuyen Pham, ALBA-Singapore
- Wilson Pandhika, Pan Era Group
- Wimonrat Santadvatana, Wongpanit

JANUARY 2023

Mapping Local Plastic Recycling Supply Chains: Insights from Selected Cities in India, Indonesia, Thailand and Viet Nam

