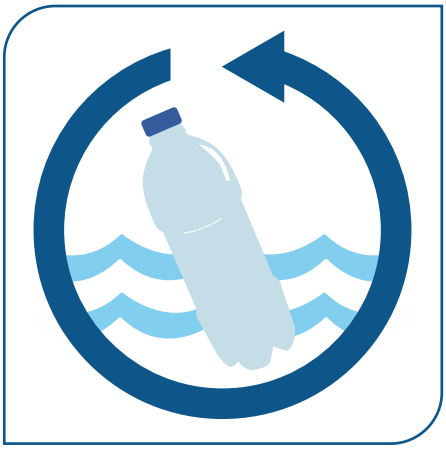
CLOSING THE LOOP

Innovative partnerships with informal workers to recover plastic waste, in an inclusive circular economy approach

PUNE, INDIA CASE STUDY













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SWACH
A higher level of self-reliance

SEI

Acknowledgements

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Abbreviations

HDPE	high-density polyethylene
KKPKP	Kagad Kach Patra Kashtakari Panchayat trade union
MOU	memorandum of understanding
PET	polyethylene terephthalate
PMC	Pune Municipal Corporation
SWaCH	Solid Waste Collection and Handling cooperative

1. Introduction

Management of recyclable waste in Pune, India follows a hybrid model involving informal workers and is widely considered a success story in this sector. One important factor in understanding this achievement is the city's history of informal workers' rights movements and civil society participation. This case study retraces plastic waste streams in the city of Pune, identifies contributions by informal economy workers to the recovery, sorting and recycling of plastic waste and provides policy insights that aim to harness the environmental benefits of a more inclusive and productive waste management model. Related data were collected from June to July 2018 by researchers with the Kagad Kach Patra Kashtakari Panchayat trade union and the Solid Waste Collection and Handling (SWaCH) cooperative and were then validated at a city workshop in Pune in August 2018.

KEY MESSAGES

- Systems for separation, collection and recycling of waste (including plastic waste) already exist in many Asia-Pacific cities, like Pune.

- The experience of the Pune municipal waste management model (SWaCH model) shows that informal waste workers are active and effective in recovering and valorising resources, and this workforce-based approach can have positive economic, social and environmental impacts.

- The Pune informal waste management model undertakes plastic waste collection and recycling activities at a much lower cost than conventional or formal mechanized and centralized waste management approaches. The informal waste pickers save an estimated 900 million rupees (US$12.5 million) each year in labour, transportation and processing costs. This amount represents 46% of the entire capital budget of Pune's solid waste management system. This equates to the PMC having to budget 2.7 billion rupees (US$39 million) over three years in the absence of the informal waste picker driven SWaCH Model.

- The Pune model also achieves considerable plastic waste segregation and high recycling levels, with an estimated 30,000 tonnes of plastic material annually collected and sent for recycling by the SWaCH waste pickers, diverting 52 per cent of the plastic waste in Pune from landfills. The annual greenhouse gas reduction from plastic waste diversion and recycling is estimated to be approximately 50,000 tonnes of CO2 equivalent. This is comparable to removing more than 10,000 passenger cars from the roads.

- It is important that state and regional authorities understand the role that waste pickers and other informal actors have in the development of a more circular plastic economy. Decision-makers should further recognize and legitimize the current informal worker-based waste management model – building on the existing system rather than dismantling it. It is important to ensure that long-term political and financial support are provided to the informal workers and SWaCH.

- It is important to support the positive contributions of the model and address the need for improving plastic waste collection, recycling and reduction of the plastic leakage to the environment (by increasing awareness, providing space for waste pickers to sort and store their materials, motivating the informal workers to register without fear and punishment, and motivating the informal actors to follow the procedures that reduce the plastic leakage to the environment, etc.). This would help identify further development pathways that leave no one behind in the transition to more circular economies.

2. Policy context

Pune is India's ninth-most populous city and the second-largest urban agglomeration in Maharashtra State. It is one of the fastest-growing cities in the country, increasing in population at an annual rate of 4.1 per cent since 2001 (see also box 1 for more details).[1] Pune has struggled with the growing levels of municipal solid waste since the early 1990s, when its waste collection system – as in many cities in India – consisted of public containers in which citizens deposited their solid waste daily and which informal waste pickers would sort through to find recyclable items

Box 1. Pune at a glance

- Pune city is part of the Pune Urban Agglomeration, which has a population of more than 5 million persons, according to the 2011 India Census data.[2]
- Pune city has a population of 4 million persons. There are 1.2 million residential, commercial and institutional properties spread across the city.[3]
- Urban sprawl is taking place – population density in Pune in 2011 was 170 persons per hectare, decreasing at an average annual rate of -4.8 per cent since 2001.[4]
- Pune city occupies around 331 square kilometres and is under the jurisdiction of the Pune Municipal Corporation, established in 1959.[5]
- Some 25 per cent of Pune city's properties are located within declared (recognized) slums, housing almost 40 per cent of its population.[6]
- The average literacy rate is 95 per cent for men and 87 per cent for women, according to the 2011 India Census data.[7]
- Average per capita income is 111,637 rupees (US$1,600) per annum.[8]
- The estimated daily waste generation in Pune is 2,000 tonnes (730,000 tonnes per year).[9]
- Per capita waste generation is approximately 145 kg across economic classes.[10]

Poor, illiterate, voiceless, ignored and even despised by some, the city's marginalized waste pickers came together to express their right to dignity and a safe livelihood by forming their own union, called Kagad Kach Patra Kashtakari Panchayat (KKPKP) in 1993. Initially motivated by a desire to counter harassment by police and municipal authorities, the movement expanded to demand recognition for waste pickers by the local municipal government for their contribution to the city's environmental and financial well-being through increased recycling and the reduction of waste going to landfill. They also sought the preservation of their livelihood through secured access to waste and being integrated into the city's formal municipal solid waste management system.

In coalition with other civil society organizations active in city-level environmental issues, the KKPKP developed a sustainable municipal solid waste management strategy, created basic communication materials and worked closely with municipal commissioners to advocate for their decentralized solid waste management model. KKPKP leveraged a combination of research, policy and political support to make the case that the Pune Municipal Corporation (PMC) should recognize waste pickers as workers

providing critical urban environmental services. KKPKP effectively worked with PMC to be authorized to formally perform primary waste collection services. The KKPKP efforts were a success, and Pune became one of the first local governments in India to provide waste pickers with identity cards and cover their health insurance payments, both of which were significant achievements, considering that the PMC had no direct employer-employee relationship with waste pickers.

2.1 National changes in the municipal solid waste management landscape

In 2000, the country's national policy radically changed as a result of public interest litigation filed against the Government regarding poor municipal solid waste management in large cities. The Planning Commission formed a committee to suggest improvements to solid waste management practices. KKPKP and other network organizations were represented in the consultations that were conducted, and the committee ultimately recognized waste pickers' role in municipal solid waste management. The Supreme Court then passed a landmark judgment that led to the passing of the national Municipal Solid Waste (Management and Handling) Rules 2000. The Rules mandate urban authorities to collect waste door to door, to promote waste segregation at the household level and to divert waste away from landfills and into recycling and processing systems.

The introduction of mandatory door-to-door waste collection through a local municipal authority was proposed to reduce littering. But the removal of waste containers directly would affect waste pickers' access to recyclable items across the city. PMC, not having the sufficient human resources to undertake such a collection, was set to outsource doorstep collection to labour contractors, thereby further reducing waste pickers' access to waste and enriching private contractors in the process. To counter this potential threat to their livelihood, KKPKP waste pickers sought to alter their access to recyclable waste by encouraging conscientious citizens to give their waste to waste pickers directly from their doorsteps for a small user fee, instead of depositing it in containers or handing over to the municipal system. Thus, instead of foraging for recyclable items from the streets and containers, waste pickers began providing a doorstep collection service, radically improving their working conditions and introducing an additional source of income in the form of waste-collection user fees. A pilot project marginally supported by the local body through appeals to citizens and provision of basic equipment, such as pushcarts and buckets, enabled KKPKP to establish a door-step collection system for almost 50,000 properties across the city.

Box 2. Supportive national and state legislation

1993: Pune waste pickers form their union, Kagad Kach Patra Kashtakari Panchayat (KKPKP).

1995: The report of the High-Power Committee on Solid Waste Management in India, constituted by the Planning Commission, calls for integration of waste pickers into the municipal system; formation of cooperatives for door-to-door collection of waste; waste segregation; ward-level recovery centres; incentives for recycling; and composting and other waste treatments.

2000: The Municipal Solid Waste (Management and Handling) Rules introduce mandatory doorstep collection, promote waste segregation at source, and the recycling of dry waste and diversion of waste away from landfills.

2002: The Maharashtra Government Water Supply and Sanitation Department Resolution addresses the allocation of work of door-to-door collection of waste generators through a cooperative of waste pickers on a user-fee basis.

2006: The Maharashtra Non-Biodegradable Solid Waste (Proper and Scientific Collection, Sorting and Disposal in the Areas of Municipal Corporations) Rules provides safe sorting spaces (material recovery facilities) for waste pickers, which enable the diversion of recyclable items through the informal sector.

2007: The Urban Development Department of Maharashtra sets a deadline of December 2007 for each city to submit an action plan for implementing the Municipal Solid Waste Rules 2000, including 100 per cent door-to-door collection.

2008: The Pune Municipal Corporation (PMC) authorizes the Solid Waste Collection and Handling (SWaCH) cooperative to provide door-to-door waste collection and other waste management services for five years.

2012: The Central Ministry of Urban Development Circular requires recognition of waste pickers, including identity cards and personal protective equipment for them, and integration of waste pickers into the formal municipal solid waste management system.

2013: The first memorandum of understanding between the PMC and SWaCH ends, at a time when more than 390,000 properties are being serviced.

2014–2015: The SWaCH model continues in absence of PMC administrative support.

2015: KKPKP represents informal waste pickers in the Government's drafting committee for the updated Solid Waste Management Rules (to be released in 2016).

2016: The Solid Waste Management Rules continue to acknowledge informal waste pickers, waste collectors and recyclers as a crucial element of solid waste management and introduce requirements for registration and involvement of waste pickers in the formal municipal solid waste management system; local authorities are required to recognize the workers and provide them with an identity document to be formerly registered; setting up material recovery facilities and providing space for sorting; free and easy access to recyclable items from source or the material recovery facilities; directing waste generators to hand over segregated recyclable waste to waste pickers; and provide training and personal protection equipment to all workers handling solid waste.

2016: The PMC renews its contract with SWaCH for another five years.

2016: KKPKP represents informal waste pickers in the Government's drafting committee for the Solid Waste Management Rules 2016.

2018: SWaCH expands to cover 640,000 properties with some 3,000 waste-pickers.

2.2 Transforming the Pune municipal solid waste management system

A possibility for the PMC to develop further collaboration with informal workers collecting waste arose in 2007. The Urban Development Department of Maharashtra State set a deadline of December 2007 for cities to each submit an action plan for implementing the Municipal Solid Waste Rules 2000. This included achieving 100 per cent door-to-door collection by the set date. Preference was to be given to cooperatives of waste pickers for undertaking the waste management, with a user fee for the door-to-door collection. It was in this context that PMC took the opportunity presented by KKPKP to launch a new PMC–SWaCH cooperative model, which led to transformative changes in the city's municipal solid waste management system.

SWaCH is India's first cooperative owned by self-employed waste pickers. In 2008, SWaCH was authorized by the PMC to provide door-to-door waste collection and other allied waste management services for a period of five years. The waste pickers receive the service fee, and SWaCH is accountable to residents as well as the PMC; it must comply with the performance indicators specified in the memorandum of understanding (MOU) signed with the municipality. The recyclable items collected at source are sorted and sold by the waste pickers, and all the income generated from this activity is retained by them.

All persons in SWaCH are working members, not merely shareholders, with the portion of women at more than 80 per cent. SWaCH also includes representatives from Kothi Councils, which are geographical administrative units at the neighbourhood level, and with persons from the city-level Representatives Council. The Council consists of elected representatives from neighbourhood Kothi Councils across the city who meet monthly to facilitate workers' participation in operations and decision-making processes.

The SWaCH model provides multiple benefits of sustainability, inclusion and efficiency. While SWaCH provides the workforce, the PMC recognizes the waste pickers and provides access to waste, supplies equipment and covers the administrative costs of the cooperative. The SWaCH waste pickers collect waste door to door, segregate the recyclable material and dispose the remaining waste at designated points in the secondary waste collection system. Coordinators at the *kothi*, or neighbourhood, level ensure that user fees are collected, complaints are addressed and value-added services (such as composting and e-waste collection) are provided. The waste pickers fill an important gap by reclaiming recyclable waste and providing raw material for the formal recycling chain.

In 2013, at the end of their first MOU with PMC, 2,200 members of SWaCH serviced more than 390,000 properties in Pune. For the next two years, the SWaCH model continued in the absence of any administrative support from the PMC but was unable to expand its services. It continued with a skeletal team of 14 coordinators and administrative staff. Recognizing the sustainability of the model, the PMC renewed its contract with SWaCH in 2016 for five years. As of August 2018, approximately 640,000 properties were serviced by 3,076 waste pickers.

The pioneering work of KKPKP and the SWaCH model's sustainability resulted in the trade union being asked to represent informal waste pickers in the Government's drafting committee for the Municipal Solid Waste Rules 2016. The impact of this inclusion can be seen in the various provisions of the Rules that support the recognition of waste pickers and their integration into the formal municipal solid waste management system of cities. Cities are now required by law to recognize informal waste pickers, provide them with identity cards and to integrate them into doorstep collection, thereby preserving their livelihood. At the local level, KKPKP was involved in the drafting of the PMC Public Health and Sanitation by-laws, covering every aspect of waste (solid waste, e-waste, biomedical waste and plastic waste), which explicitly provide for better recognition and stronger involvement of waste pickers.

CLOSING THE LOOP

Unlocking an Inclusive Circular Economy Approach for Plastic Waste Management

+5 million people

2000 tonnes of municipal waste daily

Only 8.3% of municipal waste is **PLASTIC** but this is still equivalent to **166 tonnes per day**.

Plastic waste, including microplastics, are pervasive in the organic waste that accounts for almost 3/4 of all waste.

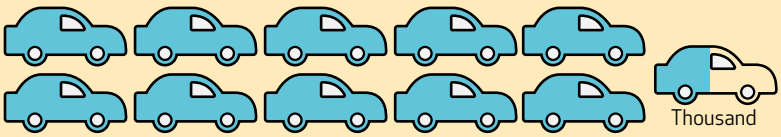
87.5% of Pune's total municipal waste is collected, with **informal workers,** working under contract from the municipality, **gathering over 50%**.

Informal workers remove enough plastic waste from Pune to account for nearly

50,000

TONNES OF ANNUAL CO_2 EMISSIONS

This is the equivalent to CO_2 emissions...



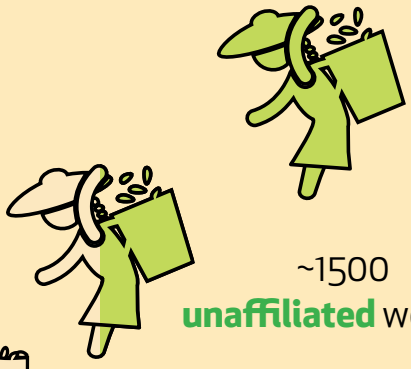
...from **10,423 passenger cars**...

...burning **20,611,991 litres** of petrol.

Some organization amongst the informal workers is already established.

KKPKP trade union has **~7000** members,
including **~3000** who are also members of **SWaCH** co-op

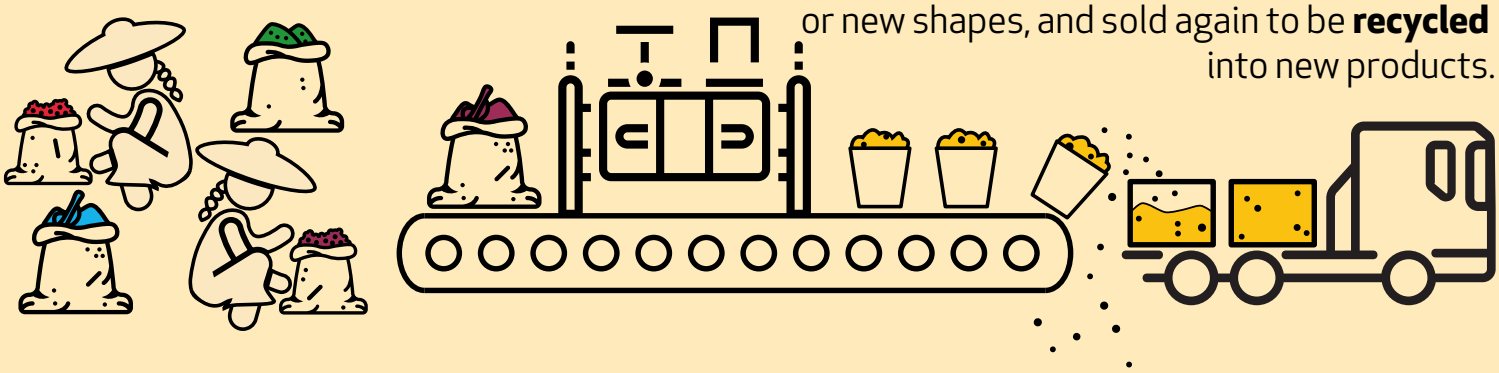
Waste pickers sell their recyclable materials to any one of **600 small and medium scrap shops**.



~1500 **unaffiliated** workers

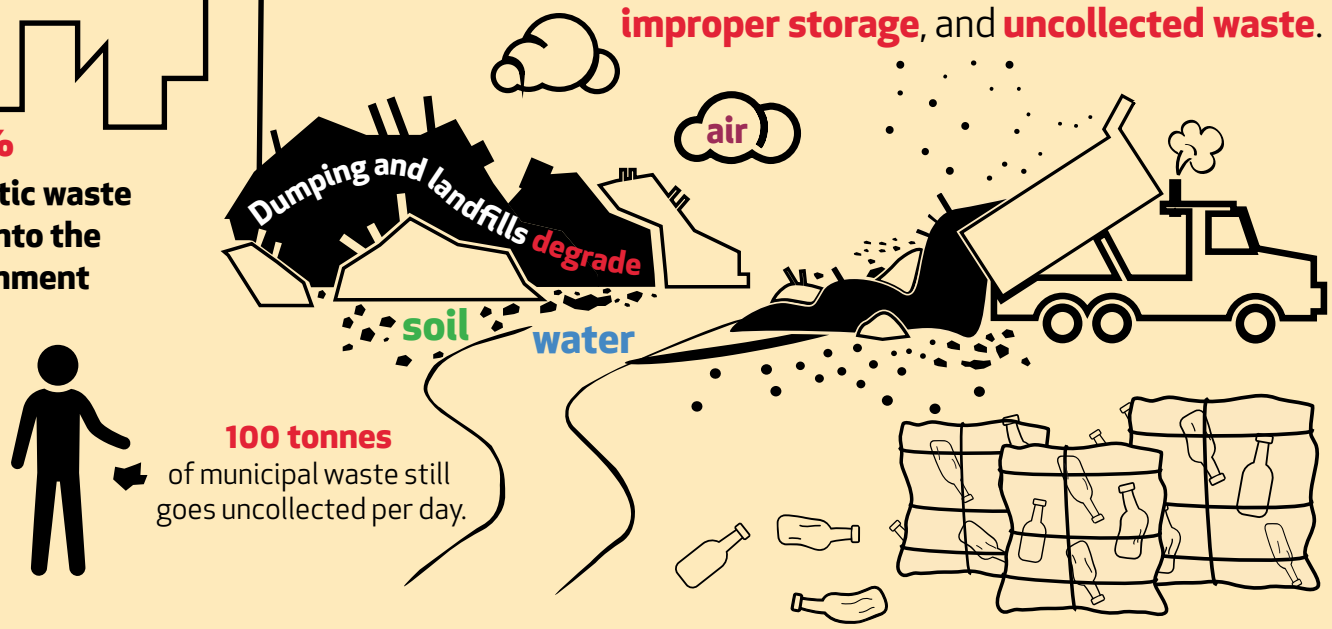
Each type of plastic waste has an individual market value.

The materials are **sorted** further,
sold on to be **processed** into flakes, pellets,
or new shapes, and sold again to be **recycled** into new products.



However, **leakages** in the plastic recycling value chain still exist in multiple forms including **illegal dumping**, **improper storage**, and **uncollected waste**.

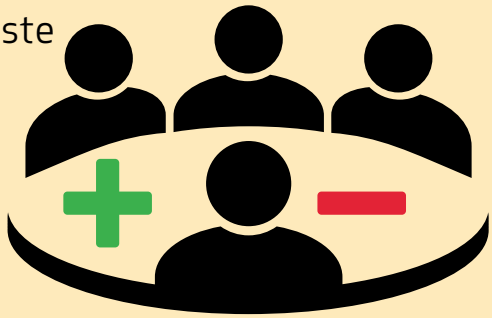
12.5%
of plastic waste leaks into the environment

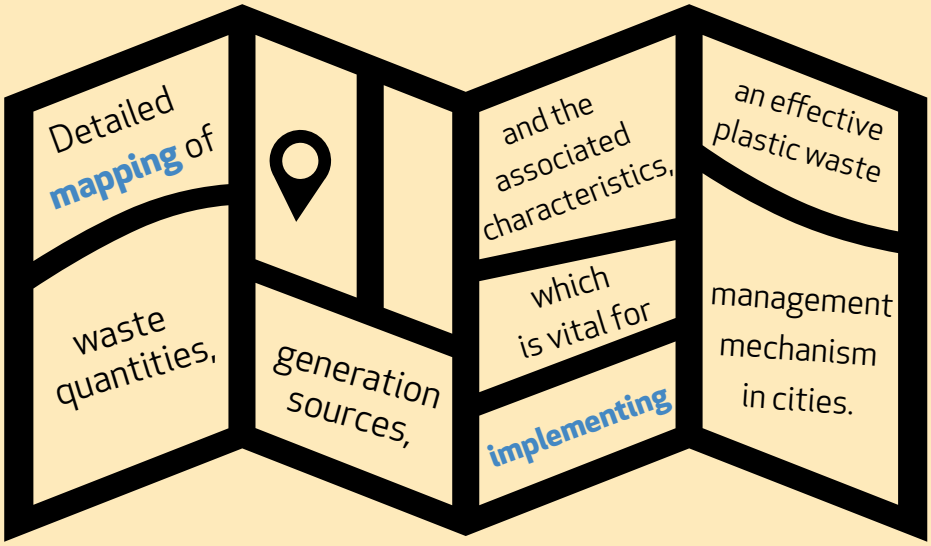


100 tonnes
of municipal waste still goes uncollected per day.

Key actions to address plastic waste leakages into our environment include...

Increasing awareness and **education** about the **benefits** of waste segregation and the **harms** of dumping and littering.





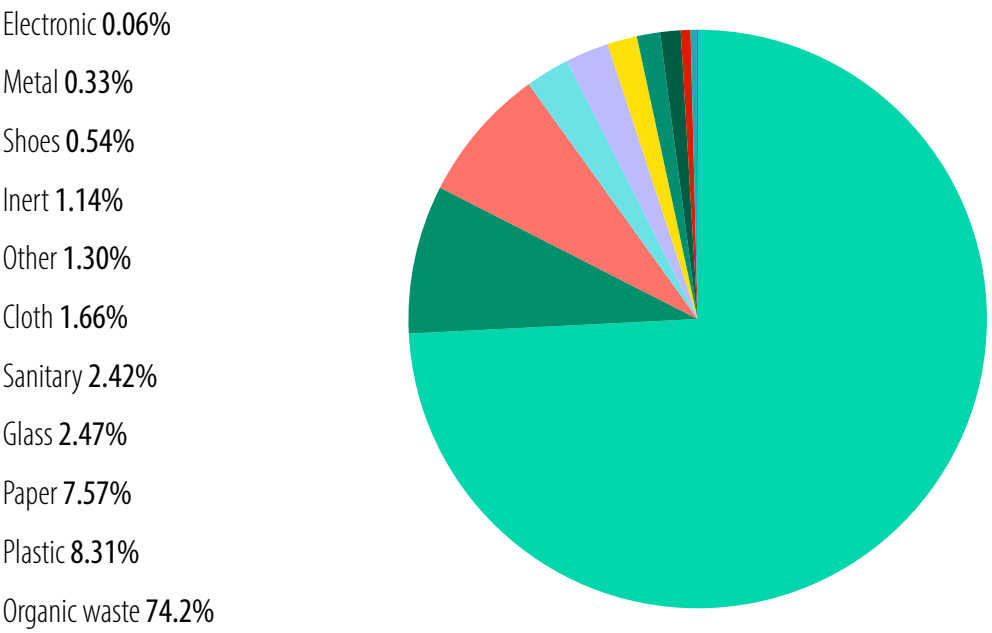
3. Municipal solid waste management in Pune

The commercial industries, hospitals, hotels and residential buildings in Pune create approximately 2,000 tonnes of municipal solid waste daily. By 2025, the projected total amount of municipal solid waste that will be generated and managed by PMC will rise to 3,255 tonnes per day.[11]

Approximately 70 per cent of the municipal solid waste is generated by households, while hotels, restaurants and other commercial establishments together account for the other 30 per cent.

The composition of the solid waste is categorized into three groups: compostable, recyclable and inert. Compostable or organic fractions (wet waste) that consist mainly of biodegradable market waste and food waste account for almost three quarters of the total solid waste (see figure 1). Recyclable waste includes paper, plastic, glass and metal. The fraction of solid waste that can neither be composted nor recycled into secondary raw material is referred to as inert and includes stones, ash and silt that enter the collection system mainly due to street cleaning and construction and demolition activities.

Figure 1: Composition of municipal solid waste in Pune



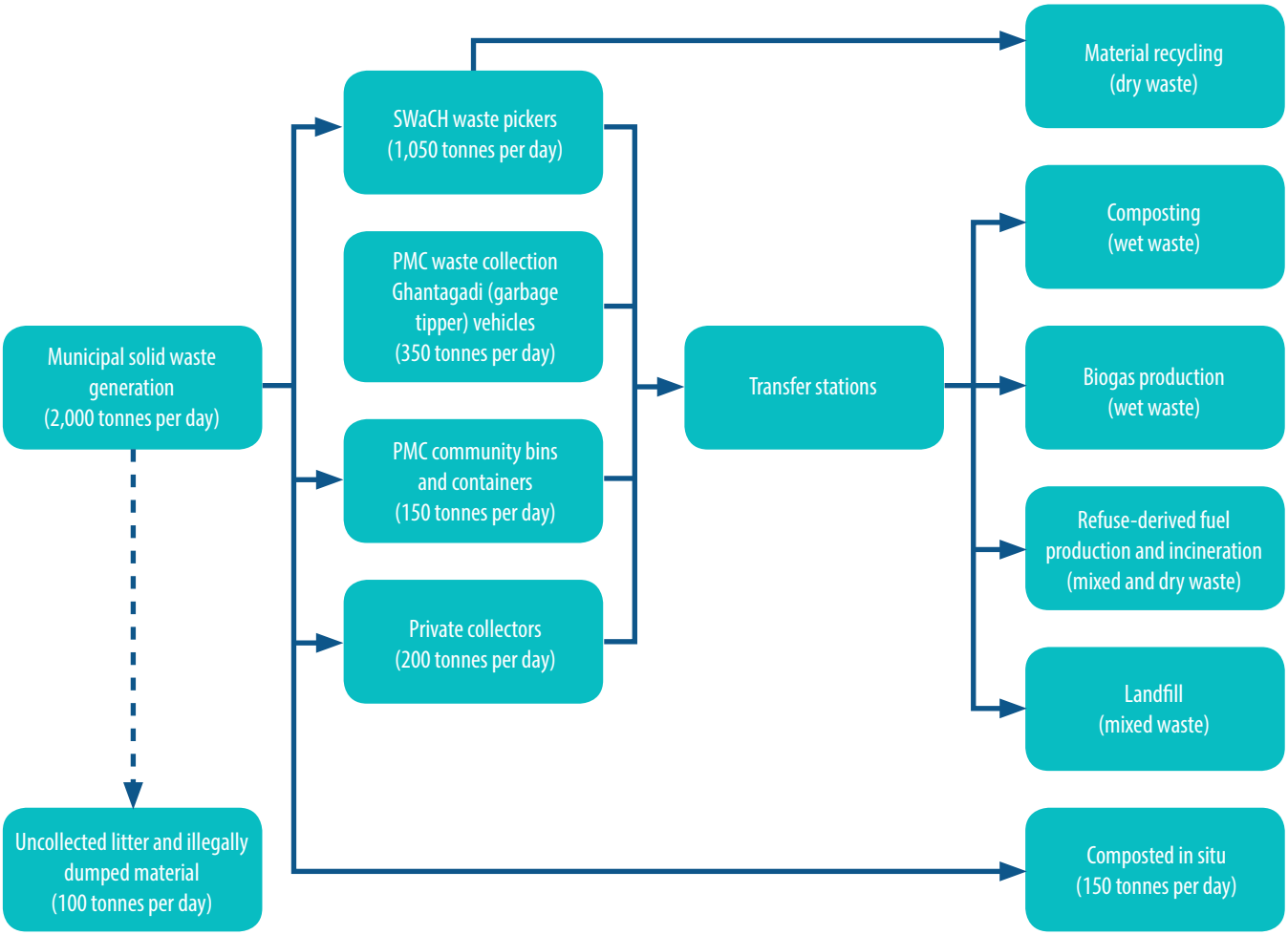
Source: Pune Municipal Corporation, SWaCH Quarterly Report to PMC (Pune, 2018).

Approximately 87.5 per cent (1,750 tonnes per day) of municipal solid waste in Pune is collected and treated using various disposal methods.[12]

The PMC organizes the transportation of solid waste through a fleet of vehicles and dumper-placers. Collection is managed by different entities, based on the origin of the waste. As of 2018, SWaCH was collecting approximately 52.5 per cent of the municipal solid waste (1,050 tonnes per day) in the city through its network of waste pickers. Government waste collection vehicles picked up 17.5 per cent, or 350 tonnes per day, while private non-affiliated operators retrieved 10 per cent, or 200 tonnes per day, with 7.5 per cent (150 tonnes per day) collected through community bins and containers (see figure 2). In addition to the waste collected by these various systems, approximately 5 per cent (100 tonnes per day) remained uncollected, and 7.5 per cent (150 tonnes per day) was composted at source by citizens.[13]

Pune city has a combination of waste-processing technologies deployed at various levels (decentralized and centralized). A total of 50 waste-processing plants (7 centralized and 25 decentralized biogas, 14 decentralized biodigesters and 4 mechanical composting facilities) process 30 per cent of the waste (515 tonnes per day). Approximately 7.5 per cent of the waste generated is processed, in situ, by residential and commercial properties, while 7 per cent (145 tonnes per day of only wet waste) is diverted to farmers in nearby villages. About 10 per cent of waste collected (170 tonnes per day) is diverted towards recycling by the SWaCH waste pickers. The remaining 60 per cent (1,065 tonnes per day) is sent to landfill.

Figure 2: Municipal solid waste management in Pune city



Source: Authors.

4. Plastic waste value chain

Plastic waste accounts for 8 per cent of the total municipal solid waste generation in Pune, equivalent to 60,600 tonnes per year (166 tonnes per day).[14] Mixed plastic bags and packaging (so-called "mixed men", or low-grade flexible plastic) make up almost half (48 per cent) of the plastic waste stream. Plastic chip bags and packets (multilayer laminates) represent 16 per cent, plastic high-density polyethylene (HDPE) containers (such as shampoo bottles) constituting 16 per cent, while milk bags (high-grade low-density polyethylene are 7 per cent and polyethylene terephthalate (PET) bottles are 5 per cent, all of which constitute the majority of the plastic waste (see figure 3).

Figure 3: Plastic waste composition in Pune city

PVC pipes **0.08%**

Cement bags (Rafiya) **0.18%**

Bicycle seats and Rubber Tubes **0.34%**

Tetrapak (Juice Dabba) **1.21%**

Small plastic pieces (Kadak) **1.38%**

Styrofoam (Tharmocol) **2.11%**

White high grade film plastic (LD) **2.42%**

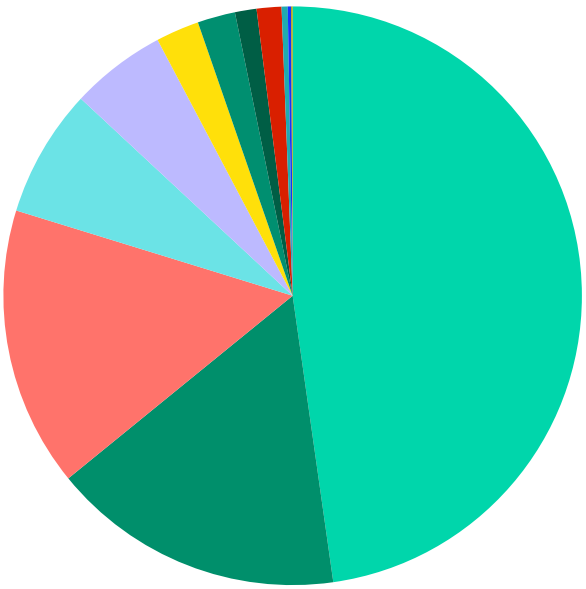
Thick PET bottles (Kadkadi) **5.34%**

Milk Bag (Doodh Pishvi) **7.17%**

HDPE containers (Phuga) **15.63%**

Chip bags and packets (Kurkure) **16.37%**

Coloured Plastic Packaging (Mixed Men) **47.76%**



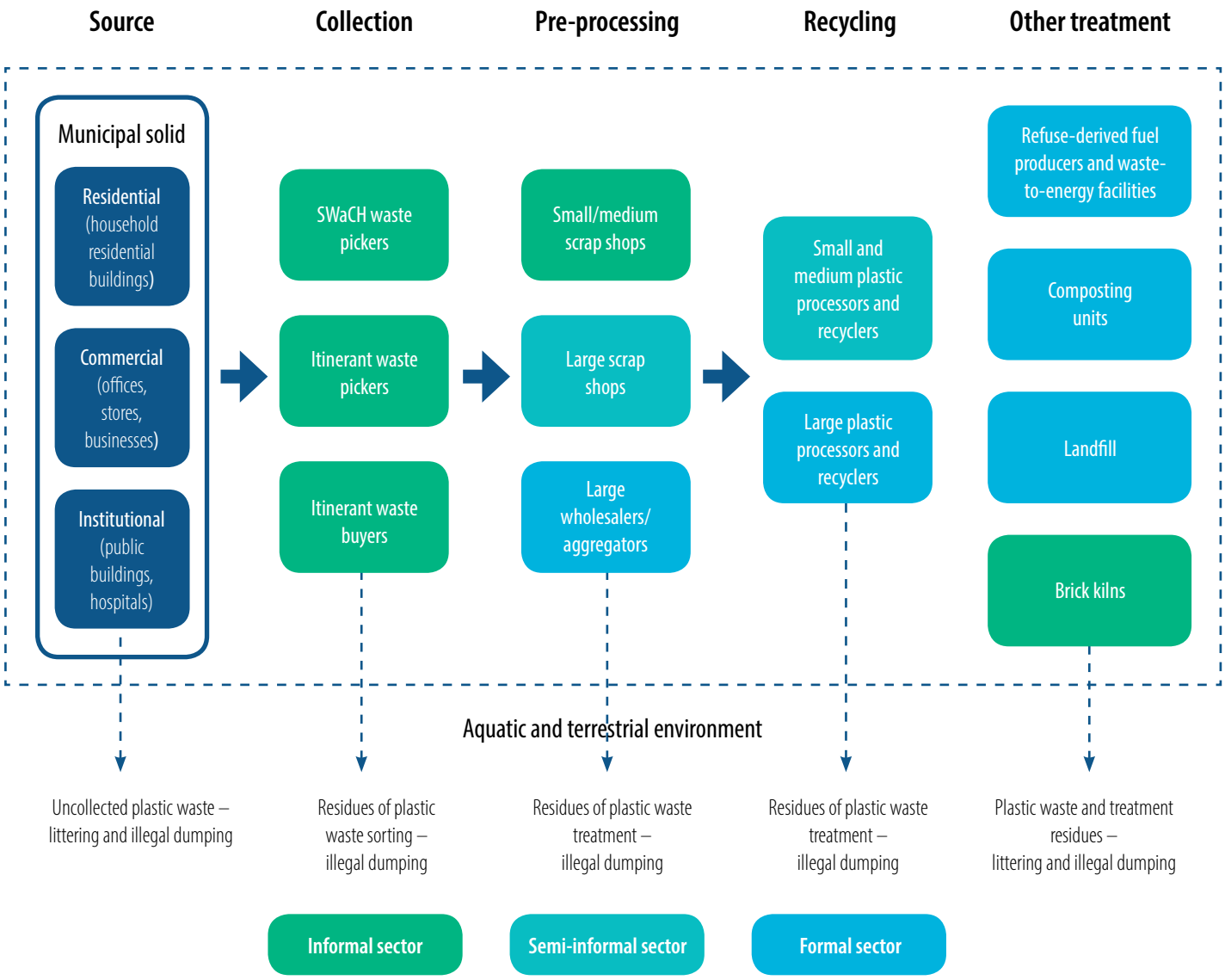
Source: Pune Municipal Corporation, SWaCH Quarterly Report to PMC (Pune, 2018).

Approximately 70 per cent of plastic waste is packaging. This indicates that the main source for plastic waste in Pune is related to the consumption of packaged products (mainly food and beverages). Of the branded packaging waste, 86 per cent is from food product packaging, followed by 8 per cent from personal care products and 6 per cent from household products. And 87 per cent is attributable to Indian (local and country-level) brand owners, while only 13 per cent is associated with international brand owners.[15] Plastics are also used in a growing range of building and construction applications (pipes, tubes, cables, etc.), which are another large source of plastic waste.

The establishment of the Pune waste management model has helped to achieve a relatively high recycling rate of plastic waste. Approximately 50 per cent of the plastic waste generated is collected and recycled, which is much greater than the average plastic recycling rate (10–20 per cent) in many European countries and the United States. This relatively high plastic waste segregation and recycling level is achieved thanks to the waste pickers who provide an efficient and low-cost collection and segregation service in all parts of the city (including slums).

The informal workers are active at all levels of the plastic waste recycling value chain. Overall, the informal and formal actors complement each other and are highly interlinked. Within the value chain, the ownership of plastic materials can switch several times between formal and informal actors (see figure 4).

Figure 4: Plastic waste recycling value chain in Pune



Source: Authors.

4.1 Collecting and sorting plastic waste

The 3,000 SWaCH waste pickers are integrated into the door-to-door waste collection. The collected recyclable items (including plastic waste) are segregated manually by the waste pickers on the premises of a waste generator, in sorting sheds, in the open or wherever they can find a space. The SWaCH waste pickers receive income from the payment of the user fee from households and from the recyclable materials they sell to itinerant buyers and scrap shops. The non-affiliated itinerant waste pickers (approximately 4,000 of them) collect recyclable items from businesses, the streets and dump sites. They earn revenue only from the sale of these items.

The waste pickers have a crucial role in plastic recycling because the collection and segregation of the plastic waste is mainly carried out by them. The waste pickers are able to collect and segregate various plastic types from different sources, such as households, slums, the commercial sector, streets and landfills, which conventional waste collection systems are not able to carry out. For example, the SWaCH waste pickers collect 30,000 tonnes of plastic waste per year, of which 15,000 tonnes is segregated and sent to recycling. There were no available data about the contribution of non-SWaCH waste pickers, but presumably they are also segregating plastic waste.

The plastic recycling value chain actors are usually skilled at identifying the plastic waste with value and locating potential customers for it. However, not all plastic waste is suitable for recycling, nor would the recycling always be profitable – for example, certain plastics and thin carrier bags have a low value and are thus less likely to be collected. The degree to which the plastic waste is collected and recycled depends on many aspects, such as the existence of a market, the price of virgin materials and the potential profit margin, the existence of supply and demand for secondary plastic materials, the level of accessibility, the quality of the collected plastic items, seasonal variations, collection and segregation conditions and the convenience of processing the collected plastic materials.

4.2 Trade and pre-processing

The next link in the value chain are the scrap shops that purchase small quantities of recyclable material from waste pickers or directly from households. There are approximately 600 small and medium-sized scrap shops, 50 large scrap shops and 30 larger wholesalers and aggregators in the Pune area. Most of the small and medium-sized scrap shops belong to the informal or unofficial waste sector because they are individually owned proprietorships without any waste-specific registration from the PMC or the State Pollution Control Board.

Typically, the owners of scrap shops are small informal traders earning marginally more income than waste pickers, with many hailing from families of waste pickers. All categories of scrap shops rudimentarily sort and compress collected plastic waste to re-sell by weight or unit for onward processing and recycling. Sorting by polymer, colour and quality is often conducted several times and at different locations in the value chain, with varying levels of effectiveness, which influences the quality of the handled waste items at each level.

In Pune, waste collection and recycling follow a purely commercial logic – waste pickers tend to prioritize the collection of heavy-weight and low-volume plastics, such as PET, high-density polyethylene and certain types of hard plastics (polypropylene and polystyrene) that can be sold at higher value. Low-weight and high-volume plastics, such as soft-coloured low-density polyethylene (mixed men), are less valuable and are further devalued during the monsoon season because of their high moisture content. Also, some of the mixed plastic materials (mixed men, plastic chip bags and other hard-to-recycle food packages) that form a large share of the overall plastic waste do not have commercial value as a secondary raw material and therefore are usually not bought by scrap shops. This means that many plastic items and types remain uncollected and not recycled.

The price paid for a certain type of plastic material depends on its quality and quantity. Value can be added to the collected plastic materials by cleaning, classifying, washing, compacting and aggregating them. The level of plastic waste collection and recycling in the city is directly proportionate to the number of locations and the amount of space provided for these activities in a decentralized manner. While Pune leads all other Indian cities in terms of sorting sheds provided to waste pickers, there is significant room for improvement. Only 550 of the 3,000 SWaCH waste pickers have access to a sorting shed, where waste can be safely sorted and temporarily stored prior to sale. Similarly, there are no provisions in the municipal development rules and land regulations to provide space at commercial or subsidized rates to scrap shops and for the development of recycling markets. Thus, many waste pickers are forced to sort

and store the recyclable items in public places. Without adequate storage space, collected plastic material cannot be held until it can fetch a higher price, and unsheltered materials can be degraded or ruined by weather. This has a negative impact on the volume and quality of plastic waste collected.

4.3 Recycling

Further processing of plastic waste is carried out by small and large plastic recyclers who mainly focus on processing plastic (sorting, cleaning, flaking and pelletizing) before it is sent to the final users of recycled plastic (in India or abroad) who produce new plastic products. Plastic waste processing units are located not only in Pune city but are scattered across Maharashtra State, with some areas that are specialized in certain processing activities of the recycling chain. The processing units usually specialize in a few plastic or polymer types. Their technical level can vary greatly. Some have relatively modern technology, others use basic equipment that allows for little quality control. Many of these units belong to the informal actors and often do not have any registration with the State Pollution Control Board and do not strictly comply with the labour and environmental laws and regulations. It is common that the formal recyclers source from and sell to informal processors.

Plastic waste is segregated manually by the waste pickers. They use simple methods to identify the different types of plastic, mostly based on its visual quality (shininess or colour) as well as its hardness and other crude methods. However, the identification and proper segregation of different plastic materials is a challenge and has resulted in a low quality of segregated materials. The increasing use of bio-based plastic materials constitutes an additional problem. It is difficult to identify biodegradable plastic, and this creates problems when it enters the recycling system together with fossil-based plastic materials.

There are still questions and data gaps regarding the seasonal variations, the long-term trends in the plastic value chain and on the full impact of the plastic ban, which is causing confusion in the supply chain. On 23 March 2018, the Maharashtra government introduced a state-wide ban on a range of plastic products, such as plastic bags, disposable plastic products (spoons, forks, cups, plates, glasses, bowls, containers and disposable polystyrene foam and other thermocol items) and plastic decoration products. The ban is applied to all persons and entities (consumers, manufacturers, retailers, etc). It also introduced a buy-back mechanism for PET bottles and milk packets. The ban imposes severe penalties on anyone found using or handling the banned items.

Although the enforcement of the ban was a welcome move to reduce non-recyclable and low-grade plastic from the waste streams of cities, it also introduced serious difficulties in the recycling of plastic waste. Unclear information regarding the ban led to scrap shops and large dealers ceasing the purchase of all flexible packaging plastic, thereby sorely affecting the recycling of such materials and the income of waste pickers. At the same time, the strict enforcement of new compliance requirements led to the stoppage of recycling operations in some of the larger recycling hubs in Maharashtra, further disrupting the recycling value chain. The introduction of the buy-back schemes of high-value recyclable materials also has the potential to disrupt the viability of the recycling sector if a substantial amount of such plastic is diverted away from the existing sector directly to manufacturers.

Subsequent iterations of the ban have introduced the principle of extended producer responsibility for manufacturers and brand owners who use multilayered packaging that is difficult to recycle. If properly implemented, these schemes present an important opportunity for upgrading the recycling sector and for maximizing the recycling of low-grade plastics, especially through the introduction of minimum support prices for the purchase of such material from waste pickers through the scrap trade.

5. Environmental impacts of informal plastic waste management

Informal workers are important for plastic waste segregation and recycling in Pune, which highlights their contributions in terms of environmental benefits.

5.1 Environmental benefits

An estimated 30,000 tonnes of plastic material are annually collected and sent for recycling with the help of the informal waste economy, diverting 52 per cent of the plastic waste in Pune from landfills. The SWaCH waste pickers save the PMC 160 million rupees (US$2 million) yearly due to their collection and diversion of recyclable plastic waste.[16] The informal economy-based municipal solid waste management model protects the environment and clearly contributes to a more circular economy by promoting the recycling of plastic waste and returning valuable materials to local and global recycling industries and producers.

The waste pickers-based collection model is also non-energy intensive (primary collection and segregation of plastic waste involves little motorized transport) and has a low carbon footprint, compared with formal and conventional technological approaches, such as mechanized, centralized waste collection schemes and incineration.

The high plastic-recycling level has had positive environmental impacts, including removing plastic from the terrestrial and marine environments, avoiding waste leakage and mitigating annual greenhouse gas emissions. The annual greenhouse gas reduction from plastic waste diversion and recycling is estimated to be approximately 50,000 tonnes of CO_2 equivalent. This is comparable to avoiding the combustion of more than 20 million litres of petrol or removing more than 10,000 passenger cars from the roads.[17]

5.2 Leakages

Although the informal waste workers in Pune contribute significantly to the collection and recycling of plastic waste, the existing model is not free of negative environmental impacts. Along the plastic recycling value chain, plastic materials still leak into the environment from several sources. The predominant source is the illegal dumping of plastic waste, which amounts to 8 tonnes per day (5 per cent of the total plastic waste generated). Certain cultural habits have dire implication for the waterways. For example, people dump plastic bags full of plastic or organic altar adornments into rivers and water bodies because it is considered the most ritually pure form of disposal.

In addition to uncollected plastic waste, the incorrect disposal or open dumping of residues from sorting and other pre-processing along with the plastic of low or no economic value pollutes the soil, air and waterways. The reason for the disposal and dumping of residues is largely due to the lack of awareness among the informal workers. There is also no proper and efficient collection system for refuse and residue that are generated by scrap shops and recyclers outside of regulatory control and enforcement, which thus results in the leaking of an estimated 5–10 per cent of treated plastic waste into the environment through illegal dumping.

Many scrap shops and recyclers tend to discard or dispose plastic residues or discharge the water from the plastic pre-treatment and washing process into the environment from the processing sites. Some larger dealers of plastic recyclable items have been found sending plastic processing residues from their facilities to informal brick kilns as fuel for small furnaces, resulting in potentially toxic emissions and effluents leaking into the environment.

The infiltration of plastic items into separately collected organic waste streams also creates plastic contamination of compost that is produced from this waste. The compost that is contaminated with small pieces of plastic is then a possible source of plastic leakage into the environment, which has significant implications for human health when compost is sold to farmers for agriculture and enters the food supply.

6. Socioeconomic impacts of plastic waste management

Overall, the informal waste sector in Pune has proven to be efficient, low cost and self-sustaining. It also generates positive economic and social impacts for the city. The model saves an estimated 740 million rupees (US$10 million) each year in labour costs, at statutory wage rates, and 160 million rupees (US$2 million) in reduced waste transportation and processing costs (3,000 rupees, or US$37 per tonne of waste treated). The total estimated annual savings of 900 million rupees (US$12.5 million) when compared against the entire capital budget of Pune's solid waste management system, which for three years from 2018-2020 is approximately 5.9 billion rupees (US$82.7 million), shows the estimated financial savings during this period to be 2.7 billion rupees (US$39 million) - an amount that the PMC would have had to budget for in the absence of the waste picker driven SWaCH Model. The savings from SWaCH waste pickers allow the PMC to undertake developmental activities to the tune of 2.7 billion rupees (US$39 million) over this three year period.[18]

The SWaCH cooperative has enhanced informal workers' quality of life in the areas where they work. For example, their door-to-door collection service has resulted in better hygiene in slums and among other lower-income populations. Also, waste pickers and the other informal workers have generated employment for themselves and others as well as creating opportunities where they might not otherwise exist.

Despite many positive outcomes, the PMC–SWaCH model has faced several challenges. Although the cooperation is embedded in a legal agreement, the model seems to be vulnerable to external changes in the waste economy (price volatile) and shifts in national and local priorities. The core principle of user fee-based collection is politically volatile, with the PMC only enforcing the user fee through an administrative directive, as opposed to a legally enforceable regulation.

The model allows for interventions by locally elected representatives, PMC municipal staff and even residents, leading to obstacles to its expansion. The model also heavily depends on PMC field staff supporting its implementation by directing citizens to hand over waste and pay the user fee, by penalizing those who fail to adhere to the system and by ensuring the smooth transfer of inert and wet waste from waste pickers to the secondary waste collection system.

Waste collection from slums presents many difficulties, starting with residents regularly refusing to pay the user fee and choosing to dump and litter waste, thereby reducing the impact and efficiency of the SWaCH model in these areas.

The existence of unequal competing models (the SWaCH user fee-based collection and the PMC free vehicle-based collection) threatens the expansion of the SWaCH model. The multiplicity of waste collection systems reduces the accountability of any single operator (SWaCH, PMC or private operators).

The growing private sector and profitability of the global waste economy has affected the SWaCH model's viability also. Waste incineration and new mechanized and centralized models of primary collection could seriously affect the current waste picker-based model. As well, they do not prioritize the more sustainable approach of waste recycling and reuse. The efficiency of the informal economy often comes at the price of lack of regulation (control and enforcement) of scrap shops and accountability towards the municipal solid waste management system of the city. The absence of any system of recognition and authorization by the local authority leaves this important link in the recycling value chain out of the formal system.

7. Conclusions and entry points for action

The experience of the Pune municipal solid waste management model shows that informal waste workers are active and effective in recovering and valorising resources and that this kind of municipality and waste picker partnership can have positive economic, social and environmental impacts. This model is largely workforce based and undertakes recycling activities at a much lower cost than conventional or formal mechanized and centralized waste management approaches. It can also achieve a relatively significant plastic waste segregation and high recycling levels. It directly contributes to a more circular urban waste management model by recovering valuable materials (including plastic) for local and global recycling industries.

The Pune waste management model heavily depends on city government recognition and support. But the model is vulnerable due to external factors. The new technological options and other competing models (waste incineration, new mechanized and centralized waste management options) and the profitability of the global waste economy can seriously affect the model's viability.

Because the plastic value chain in Pune is complex and consisting of many interconnected actors, decision-makers should be cognizant of the potential knock-on effects of interventions made at any point in the value chain and be extremely careful not to disturb those actors and processes that are working effectively, such as by introducing inappropriate technologies or misguided policies (including new regulations, like the buy-back of high-value recyclable materials). Although more than half the plastic in Pune is recycled, there remains a considerable opportunity to optimize the plastic value chain to recover up to 80 per cent of plastic waste that is at least partially recyclable.

It is important to support the positive contributions of the model and address the needed improvements concerning plastic waste collection, recycling and reduction of the plastic leakage to the environment. This would help to find further development pathways that leave no one behind in the transition to more circular economies.

This report concludes with several possible areas for action:

- It is important that decision-makers understand the importance and strengths of the current waste management model. The interventions designed for a specific part of the waste management system could seriously affect other parts of the system. Decision-makers should further recognize and legitimize the current informal worker-based municipal solid waste management model – building on the existing system rather than dismantling it. The system should be expanded and standardized throughout the city to multiply its effect in terms of diversion towards recycling and reduction of plastic waste going to landfill. It is very important to ensure that long-term political and financial support are provided to the involved actors (in the case of Pune, SWaCH).

- To ensure that waste pickers and other informal actors are included in the transition to a more formal circular plastic economy, there needs to be investment in appropriate infrastructure, skills and capabilities. The level of plastic waste collection and recycling in the city is directly proportionate to the number of locations and space provided for these activities in a decentralized manner. To improve the efficiency of plastic waste segregation and attain a better quality of recyclable plastic materials, a space for sorting and recycling should be provided by the municipality: provide decentralized spaces or sorting sheds across the city for waste pickers to sort and temporarily store their materials; provide space for scrap shops, possibly with subsidized spaces or through updated land-use standards; establish recycling hubs on municipal land; provide a system of waste collection from sorting sheds; and ensure that all sorting spaces are located away from the routes of leakage of materials into the environment (canals, rivers, water bodies, etc.).

- Although the informal waste economy is relatively efficient in segregating plastic waste, the identification of different plastic materials (especially newer and emerging types of plastic materials) is a challenge and has resulted in a low quality of segregated materials. Guidance on materials and simple methods (color-coded symbols) for identifying different plastic materials is needed.

- Collection and segregation at source should be improved through a combination of awareness initiatives, incentives, fines and enforcement measures to reduce contamination between plastic and organic waste (in both directions), increase recycling rates, eliminate chronic dumping spots and minimize plastic leakages into the environment. The involvement of religious leaders could be a useful way to tackle the dumping of plastic related to cultural or religious habits.

- Increasing public awareness and providing education to informal workers on the harm to the environment of dumping plastic residues is important. It would foster an environmental identity within the sector to heighten their sense of responsibility.

- Support should be provided for low-value plastic that waste pickers currently do not collect, including measures to remove barriers to the collection, transportation and recycling of such items and the implementation of a minimum support price to incentivize waste pickers to collect them.

- Strengthening the hybrid economy around plastic waste management through the integration of the informal and formal municipal collection systems should be promoted through the registration of scrap shops in a supportive way (providing incentives for informal actors to register without fear of punishment), although this should entail the implementation of basic compliance requirements, including fire safety, prevention of dumping, ensuring that sorting and recycling residues are sent into the municipal system and ensuring that scrap shops offer fair prices to waste pickers and provide receipts.

- Producers should be encouraged to support the upgrading of the informal scrap and recycling trade as a part of their extended responsibility obligations. However, extended producer responsibility and other models that are often successful in developed countries (such as in Europe) would need to be adjusted to the situation of Asian and Pacific cities to ensure that informal workers are integrated and not just replaced by conventional technologies and approaches. For example, extended producer responsibility should focus, first of all, on low- or no-value plastic materials because extended producer responsibility on high-value materials (PET bottles) can undermine waste pickers' livelihood and will not necessarily increase diversion rates.

The follow table summarizes the challenges, entry points and actors highlighted in this case study.

Challenges	Entry points for action	Key actors
Recognition and continuous support of the existing waste management system (SWaCH model).	Recognize and legitimize the current informal worker-based waste management model – building on the existing system and not dismantling it. It is critically important to ensure long-term political and financial support are provided to the involved informal actors and SWaCH.	State, regional and local-level decision-makers
Littering and illegal dumping of plastic waste by the general public.	Increase awareness about the benefits of waste segregation and the harms of dumping and littering. Improve collection and segregation at source through a combination of awareness raising and enforcement measures, the elimination of chronic dumping spots and the minimization of plastic leakages into the environment.	All waste generators (general public, public institutions, business sector)
Dumping of sorting and processing residues of plastic waste by informal waste actors.	Increase awareness and education on the benefits of waste segregation and the harms of dumping and littering. Better management of plastic sorting and processing residues should be improved by combining education, incentives (such as providing free collection points for plastic residues), fines and enforcement measures. Strengthen the hybrid economy around plastic waste management through the integration of the informal and formal municipal collection systems, including the registration of scrap shops in a supportive way.	Informal waste actors (waste pickers, scrap shops and plastic processers)
Lack of space for sorting and storing recyclable materials.	Provide dedicated and decentralized spaces or sorting sheds across the city for waste pickers to sort and temporarily store their materials; provide space for scrap shops, and potentially subsidize such spaces or relax land-use standards; establish recycling hubs on municipal land; provide a system of waste collection from sorting sheds; and ensure that all sorting spaces are located away from the routes of leakages of materials into the environment (canals, rivers and water bodies).	Local government
Low-value plastic items are not collected.	Introduce the extended producer responsibility principle for manufacturers and brand owners who use difficult-to-recycle plastic products and packaging. Set a minimum support price to incentivize waste pickers to collect low-value plastic items. Promote the collection of such material through the informal recycling supply chain. Promote phasing out (banning) plastic materials and products that are difficult to recycle even after interventions, such as minimum support price. Avoid the negative effects of unclear implementation of plastic ban.	State, regional and local authorities
Waste pickers have difficulties in segregating the different plastic types. This has resulted in a low quality of segregated materials and therefore is a clear barrier for sorting out more plastic materials as well as the dumping of low-quality plastic items.	Develop local guidance materials and simple methods (such as color-coded symbols) for identifying different plastic materials.	Regional and local authorities, together with SWaCH and other plastic waste recycling chain actors

Endnotes

1. New York University, Atlas of Urban Expansion: Pune (2016). Available at www.atlasofurbanexpansion.org/cities/view/Pune (accessed on 1 Dec. 2018).
2. Office of the Registrar General and Census Commissioner, India Census Data (New Delhi, 2011). Available at http://censusindia.gov.in/2011-Common/CensusData2011.html (accessed on 1 Oct. 2018).
3. Pune Municipal Corporation, Monthly collected waste management data maintained by SWaCH and PMC (Pune, 2018).
4. New York University, Atlas of Urban Expansion: Pune (2016). Available at www.atlasofurbanexpansion.org/cities/view/Pune (accessed on 1 Dec. 2018).
5. Pune Municipal Corporation, Monthly collected waste management data maintained by SWaCH and PMC (Pune, 2018).
6. Ibid.
7. Office of the Registrar General and Census Commissioner, India Census Data (New Delhi, 2011). Available at http://censusindia.gov.in/2011-Common/CensusData2011.html (accessed on 1 Oct. 2018).
8. State Government of Maharashtra, Economic Survey of Maharashtra 2010–11 (Pune, 2011).
9. Pune Municipal Corporation, Monthly collected waste management data maintained by SWaCH and PMC (Pune, 2018).
10. Ibid
11. Pune Municipal Corporation, Solid Waste Management Strategic Plan 2017–25 (Pune, 2017).
12. Pune Municipal Corporation, Monthly collected waste management data maintained by SWaCH and PMC (Pune, 2018).
13. Ibid.
14. Waste Ventures and Kashtakari Panchayat, Pune Waste Characterisation and Audit Study (Pune, 2015).
15. GAIA India and Solid Waste Collection and Handling Plus, Brand Audit Report (Pune, 2018).
16. Pune Municipal Corporation, Monthly collected waste management data maintained by SWaCH and PMC (Pune, 2018).
17. The greenhouse gas emission calculation was made based on the United States Environmental Protection Agency's WARM model. See www.epa.gov/warm.
18. Pune Municipal Corporation, SWaCH Quarterly Report to PMC (Pune, 2018) and Pune Municipal Corporation, Solid Waste Management Strategic Plan 2017–25 (Pune, 2017).