

Circularity Assessment Protocol

PUNE, INDIA



Foreword

The Circularity Assessment Protocol (CAP) was born out an effort to define the concept of the circular economy in our cities and communities. While plastic pollution continues to be discussed at the highest levels of government and global organizations, cities and communities are the front lines. CAP is conducted where requested, where a city is engaged in the process. Local knowledge and expertise are the foundation of the information that the community uses, with additional data collected in partnership with CAP collaborators. Partners and teams build capacity through learning methods together. Open data collection is an important part of the process; leakage data contributes to a global open dataset. Trends across cities, countries and regions can illuminate global narratives.

Data is power to communities and enterprising individuals who are recognized for their role in materials management through CAP but are often marginalized in society. CAP data can catalyze economic development through business opportunities and subsequent interventions. The issue of plastic pollution is not for outsiders to solve in other locations, but for communities to address by collaboratively collecting data to lead themselves through the context-sensitive design of their own desired circular economy. Communities are empowered by local and global CAP data to inform their decisions about what is working, or where and how to intervene to increase circularity. Communities that participate in CAP can better define resource needs and participate in knowledge exchange.

Urban Ocean, a partnership of The Circulate Initiative, Resilient Cities Network and Ocean Conservancy, works with city leaders to bring new ideas, partners and resources together to solve interrelated problems around materials management, including addressing key priorities such as public health and economic development. A critical step in the Urban Ocean process is the Gap Assessment, which maps challenges, risks, and vulnerabilities within materials management systems and helps to develop a unique, integrated picture of the materials and circular economy related challenges and opportunities faced by each city. The CAP, developed in our Circularity Informatics Lab (CIL) at the University of Georgia, was chosen as the ideal tool to deploy as part of the Urban Ocean Gap Assessment.

The interconnected nature of complex urban systems and the value of circular economy in building resilient cities was starkly evident when the COVID-19 pandemic began just following the launch of the first Urban Ocean cohort. As a team, we immediately transitioned to online global work, with our local implementation partners becoming even deeper collaborators, conducting all field work with virtual training. This allowed for embedded ownership of the data at the local level and ultimately a powerful network of collaborators and supporters across learning cities to drive scientifically informed decision making. Local implementation partners have then continued to work with the Urban Ocean team through stakeholder workshops and into the proposal phase, as advocates for the science and key contributors in their own cities.

Urban Ocean and its partnerships provide an ideal platform to support resilient cities. CAP data can help guide interventions, create a baseline to measure success, and put essential data in the hands of the local community to drive change. We believe piecemeal solutions that are not contextually grounded are insufficient to create a systemic shift. Communities need to be involved, not just as stakeholders, but as the powerful change-makers they are.

— **Jambeck Research Group, Circularity Informatics Lab, University of Georgia**

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The Circularity Informatics Lab at the University of Georgia is committed to information sharing, data analytics, empowering communities, and systems change related to circular materials management.

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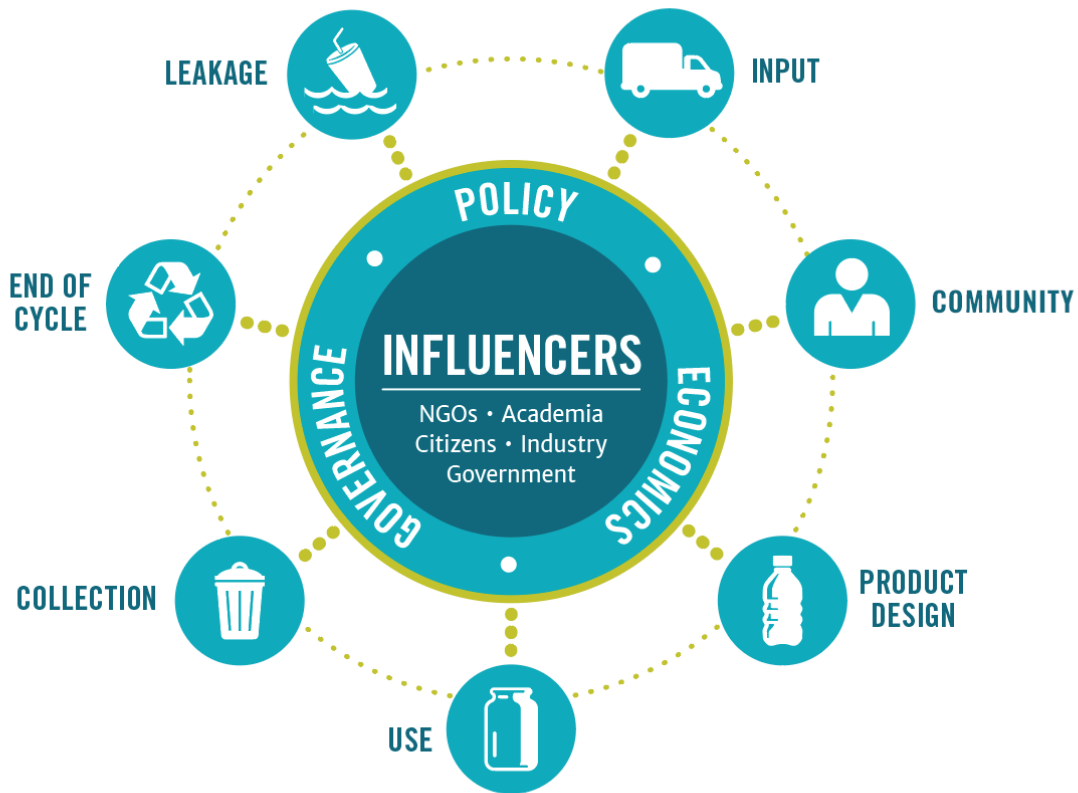
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Executive Summary

Developed by the [Circularity Informatics Lab](#) at the University of Georgia (UGA), the Circularity Assessment Protocol (CAP) is a standardized assessment protocol to inform decision-makers through collecting community-level data on plastic usage and management. Grounded in materials flow and systems thinking concepts, the CAP uses a hub-and-spoke model to holistically characterize how consumer plastic flows into a community, is consumed, and flows out, either through waste management systems or leakage into the environment. The model, shown below, consists of seven spokes: input, community, material and product design, use, collection, end of cycle, and leakage. At the center, the system is driven by policy, economics, and governance with key influencers including non-governmental organizations, industry, and government.



Between October 2020 and March 2021, a team from The Centre for Environment Education (CEE), with guidance and support from the Circularity Informatics Lab, conducted fieldwork in the city of Pune, India. The CAP was conducted with support from the city's local government, the Chief Resilience Officer (a top-level advisor in the city that is responsible for leading, coordinating, and developing a city's resilience strategy and policy), and the larger Urban

Ocean team. Fieldwork included product and packaging assessments in stores across the city; key stakeholder interviews with government, industry, and non-profit organizations; material type characterizations for consumer plastic items; cost analysis of reusable products and alternatives to plastic available in the city; visual audits of recycling contamination; identification of public waste and recycling collection bins; and litter transects in three categories of the population. Key findings from each spoke are summarized in the table below.

Urban Ocean Program

Urban Ocean is a three-way cooperative partnership among The Circulate Initiative (TCI), Ocean Conservancy (OC), and Resilient Cities Network (R-Cities) that works with city leaders to bring new ideas, partners, and resources together to solve interrelated problems around waste management. It aims to demonstrate how actions to improve waste management and recycling can provide holistic, resilient, and sustainable solutions that not only reduce ocean plastic pollution but also address key city priorities such as improving public health, promoting innovation, supporting economic development and job growth, and reducing greenhouse gas emissions through a capacity building and accelerator program for cities.

Pune is one of the cities in the initial cohort of Urban Ocean learning cities. The CAP in Pune, coupled with the upcoming Opportunity Assessment Tool, represents Stage 2 of the Urban Ocean Initiative which involves a comprehensive Gap Assessment to map challenges, risks, and vulnerabilities within the cities' critical waste management systems. The data gathered from the CAP in Pune will contribute to three workshops where stakeholders will discuss findings and develop proposal(s) for interventions that will then be brought to an Accelerator Summit for review and support, as shown by the timeline of the program below:



Get to know the partners:

Ocean Conservancy is working to protect the ocean from today's greatest global challenges. Together with our partners, we create science-based solutions for a healthy ocean and the wildlife and communities that depend on it. Since the formation of the International Coastal Cleanup in 1986, Ocean Conservancy has mobilized millions of volunteers to remove trash from beaches and waterways around the world while pioneering upstream solutions to the growing ocean plastics crisis. Ocean Conservancy invests in cutting-edge scientific research, implements on-the-ground projects, and works with conservationists, scientists, governments, the private sector and members of the public to change the plastics paradigm. To learn more about our Trash Free Seas® program visit oceanconservancy.org/trashfreeseas, and follow Ocean Conservancy on [Facebook](#), [Twitter](#) and [Instagram](#).

The Circulate Initiative is a non-profit organization committed to solving the ocean plastic pollution challenge by supporting the incubation of circular, inclusive and investible waste management and recycling systems in South and Southeast Asia. We achieve this by collaborating with key stakeholders across the sector, and by producing insights to support and accelerate investment and scale across the value chain.

The Resilient Cities Network consists of member cities and Chief Resilience Officers from the former 100 Resilient Cities—pioneered by The Rockefeller Foundation program, sharing a common lens for holistic urban resilience. The Resilient Cities Network in partnership with its global community continues to deliver urban resilience through knowledge sharing, collaboration, and creative action, seeking to inspire, foster and build holistic urban resilience around the world.

Key Findings and Opportunities

INPUT



Findings: Of the top convenience items sampled, all the chip, candy, and beverage products had parent companies that were based within India. There is interest from both the local community and local government for Extended Producer Responsibility (EPR) measures.

Opportunities

- Implement and enforce EPR domestically among top brands that have parent companies and manufacturers based in India to improve product packaging, delivery, and disposal, especially for problematic multi-layer film items from products like candy and chips.

COMMUNITY

Findings: Convenience, lack of incentives, and cost are reported as barriers for consumers and business owners to reducing use of plastic. Community members expressed confusion around formal waste collection and management, and the role of government. The community recommends more awareness on impacts of litter and some new initiatives are underway to address this. Some disconnects exist between the local government and the community, between the government and the informal waste sector, and between varying sections of the formal and informal waste sector. 62% of the community is under 30 and could be engaged in this issue to facilitate change.

Opportunities

- Reinstatement of community outreach directly between PMC and the citizens of Pune, and ideally a third-party conduit that can communicate key messages on collection.
- The local government should explore ways to improve communication and transparency with the community, as well as with local businesses and waste workers.
- Conduct an awareness campaign for citizens on the impact of littering due to tobacco packaging and cigarettes, as awareness particularly around the impact of those items is limited. Such a campaign could focus on multi-layered plastic food package littering as well.
- There are opportunities to engage younger generations in Pune around solutions and innovation.

PRODUCT DESIGN



Findings: 258 top convenience items were sampled from 47 grocery and convenience stores in Pune. Nearly 60% of all top convenience items were packaged in multilayer plastic. While 80% of top products were packaged in PET, which is highly recyclable, 100% of top candy and chip products were packaged in multilayer plastic film and 100% of the tobacco products were packaged in a plastic-coated or plastic-wrapped paper box. In contrast, 30% of to-go items sampled were made of paper. Mixed feedback was received during interviews on attempted transitions by convenience stores and restaurants to use alternatives or eliminate to-go bags, but there is interest and opportunity in this space.

Opportunities

- Explore opportunities for material innovation and EPR to either redesign multilayer plastic packaging or create value in recapturing it after it is used.
- Expand upon the use of biodegradable (paper) products in to-go items to engage with other restaurants and vendors that are still using plastic, particularly casual restaurants, and Snack Centers.

USE



Findings: Pune has a history of using alternative and reusable/refillable items, particularly for bulk convenience items, though they have been replaced by an abundance and preference for disposable single-use plastic items. Currently, single-use plastic is ubiquitous in Pune and alternatives are both often unavailable and undesired. While bans have been attempted, implementation and enforcement have been low, and with single-use items being cheaper and more convenient, there are no incentives for business owners or consumers to switch. With the general perception of lack of government coordinated solutions, some businesses have developed their own programs for fostering reusable or alternative products.

Opportunities

- Explore returning to the historic practices around refillable and reusable items, especially for top grocery and convenience items.
- Develop incentives for businesses to use alternatives or reusables.
- Investigate the businesses that are taking initiative and action in this area, as they could be used as case studies or models that could be recognized and scaled.

COLLECTION



Findings: Pune has a unique structure for its waste collection in the form of a collaboration between the Pune Municipal Corporation and SWaCH, which is a national cooperative of self-employed waste collectors in India. It is reported that around 70% of households are serviced by SWaCH through the door-to-door waste collection (DTDC), however, confusion still exists regarding the timing and efficiency of the formal collection system in the city. Pune Municipal Corporation (PMC) has set a goal of 100% coverage of door-to-door collection (DTDC) and 100% source segregation by 2025 and has made progress towards those goals in recent years.

Opportunities

- Efficiency, duplicity, and bottlenecks should be closely examined and mitigated in the waste management system of Pune.
- Re-evaluate the processes surrounding DTDC to optimize collection.
- Explore options to distribute secondary collection and transport vehicles more efficiently, improve the quality and quantity of vehicles available for collection and transport, and reduce wait times at transfer stations.
- The city should explore formalization of the informal waste sector and have an open dialogue with stakeholders about incentives that could be developed, general pros and cons, as well as other measures that could be taken to improve the safety and livelihoods of the informal waste sector and level of service, particularly headed into the PMC/SWaCH contract renewal in 2021.
- Increase public education efforts (and maybe incentive schemes, if feasible) around source segregation. Enforcement of existing mandates related to source segregation and in-situ composting should be prioritized.
- Sorting sheds and temporary storage facilities for recyclables need to be made available to SWaCH workers to sort and package recyclables for export.
- Use of ICT to set up a dashboard/app-based platform for tracing and monitoring of waste flow, especially, recyclables are required, and there are already players in the space working on this locally.
- Opportunities should be discussed in the Opportunities Assessment on how best to use the data collected by PMC on waste management in Pune, and whether this could be a model for data-informed decision-making in other cities.

END OF CYCLE

Findings: Pune has made major enhancements to their waste processing infrastructure since 2017. There are currently 50 processing plants available for dry and wet waste. However, these sites have operated at varying capacities, some of them near capacity and some below optimum capacity, which remains a challenge with a highly dynamic waste stream. The government reports 95% of the waste generated in the city is treated (PMC 2021). The city has been working to decrease its dependence on the Urali Devachi landfill, which has already capped over 35% of its capacity and is filling at a faster rate than anticipated (Sohkhlet and Nagargoje, 2020). Source segregation has improved but remains a challenge and there are disconnects between formal and informal recycling, as well as mixed feelings towards and lack of incentives for formalization. The city is currently lacking specialized treatment facilities such as E-waste, C&D waste, and garden waste.

Opportunities

- Continue to assess existing and planned processing infrastructure so that the infrastructure continues to match the needs of the city.
- Monitor the progress of the Zero Garbage pilot project in Katraj and determine whether a similar model could be feasible in other parts of Pune and what might be needed to make it successful.
- Strengthen existing or set up new material recovery facilities (MRFs) through Public-Private Partnerships (PPP).
- The city may want to develop a community-led model for recyclers – similar to its collection model – which would formalize the informal sector MSME recyclers in the city.
- The waste management department should explore source processing solutions that can be used to upgrade its 25 decentralized biogas plants processing organic waste and address specialized waste streams.

Findings: The largest percentage by category of litter items (27%) surveyed in Pune was tobacco products. Food packaging plastic represented 19% of litter items, paper was 16%, and glass was 12%. While litter densities were around average (4-5 items/m²) for the region and higher than other Urban Ocean Cohort-1 cities, common plastic items (such as personal care, food packaging plastic, fragments, etc.) were only 30% of the litter items found, much less than the typically observed 70-80%.

LEAKAGE



Opportunities

- Explore ways to reduce littering and optimize collection and processing of tobacco waste in particular.
- While Tobacco companies and manufacturers were on average located the farthest from Pune compared to those of other top product types, it is clear that those items pose the biggest challenge when it comes to litter and waste leakage – it would be worth exploring EPR measures that could be implemented (or public health messaging), starting with brands located domestically.
- If there is a desire to measure impact from interventions targeting opportunities to reduce plastic leakage, conducting transects over time, and at later periods in time is recommended.

Strengths

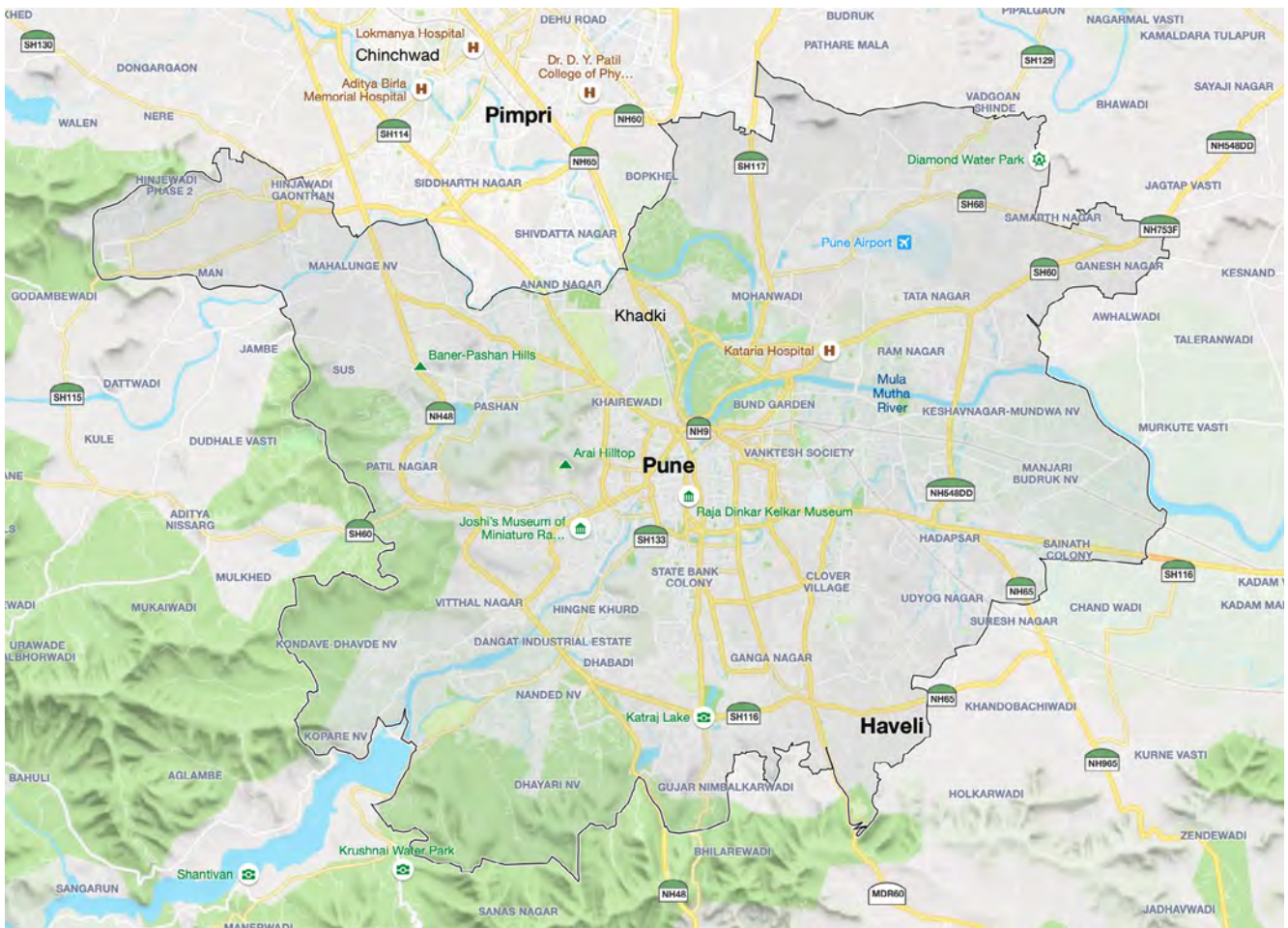
- Zero Garbage City model in progress in some selected wards
- Strong 2025 Solid Waste Management (SWM) Strategic Plan in place with ambitious and specific goals around the collection, management, and monitoring, as well as a detailed project plan from SWM that is currently with the Government of Maharashtra for approval
- Precedence set for collaborations that maximize source-segregated door-step collection (such as the partnership between PMC and SWaCH)
- Relatively small amounts of plastic in litter items (only 30% of litter items were common plastic items) and also in waste composition for the city
- Partnership with ITC Ltd (consumer products company) to set up a plastic processing plant to divert multilayered plastic towards recycling
- High household collection rates and emphasizes on source segregation, as well as a unique system that integrates informal sector waste workers into a formal system
- Options and infrastructure for decentralized waste processing, though not operating at full capacity
- PMC has drafted bylaws to be used by the city related to SWM

Glossary of Acronyms and Abbreviations

CAP – Circularity Assessment Protocol
CE – Circular Economy
CEE – Centre for Environment Education
CIL – Circularity Informatics Lab
C&D – Construction and Demolition Material
DTDC – Door-to-door Collection
EPS – Expanded Polystyrene
EPR – Extended Producer Responsibility
HDPE – High Density Polyethylene
GDP – Gross Domestic Product
IWC – Independent Waste Collector
KKPKP – Kagad Kach Patra Kashtakari Panchayat
LIP – Local Implementing Partner
MDT – Marine Debris Tracker App
MPs – Microplastics
MSW – Municipal Solid Waste
MSWM – Municipal Solid Waste Management
NMI – New Materials Institute
OC – Ocean Conservancy
PE – Polyethylene
PET – Polyethylene terephthalate
PMC – Pune Municipal Corporation
PP – Polypropylene
PPE – Personal Protective Equipment
PS – Polystyrene
RCities – Resilient Cities Network
SWM – Solid Waste Management
SWaCH – Solid Waste Collection and Handling
TCI – The Circulate Initiative
TPD – Tons Per Day
UGA – University of Georgia

Introduction

Pune is the seventh most populous and ninth-largest city in India, with a growing population of 5 million in 2021 and a population density of 5,600 people per square kilometer, and it is considered the cultural as well as the industrial capital of the Indian state of Maharashtra with a strong economy based in IT, manufacturing, and engineering. The city also has a fairly young population, as 62% of people living in Pune are under the age of 30. Pune has been documented as one of the fastest-growing cities in the Asia-Pacific region for the past 40 years, and the population is projected to reach over 5.6 million in 2031 if trends continue (World Population Review 2021). Current per capita waste generation rates for the city are around 0.5 kg/day (Mundhe et al. 2014).



Pune, India

The city of Pune has made strides in recent years towards maximizing its waste collection and management and reducing the amount of waste leakage, particularly through their Zero Waste City initiative and the SWaCH cooperative model for waste collection (Sohkhlet and Nagargoje, 2020). However, with a growing population and future projections of waste generation, Pune still faces challenges related to coping with waste and reducing plastic pollution.

As one of the cities in the initial Urban Ocean cohort, Pune has set out to characterize and understand its materials flow and waste management systems and identify associated opportunities for collaborative solutions. As a first step in the Urban Ocean process, UGA partnered with the local implementing partner (LIP) in Pune — the Centre for Environment Education (CEE) — to conduct CAP in the city.

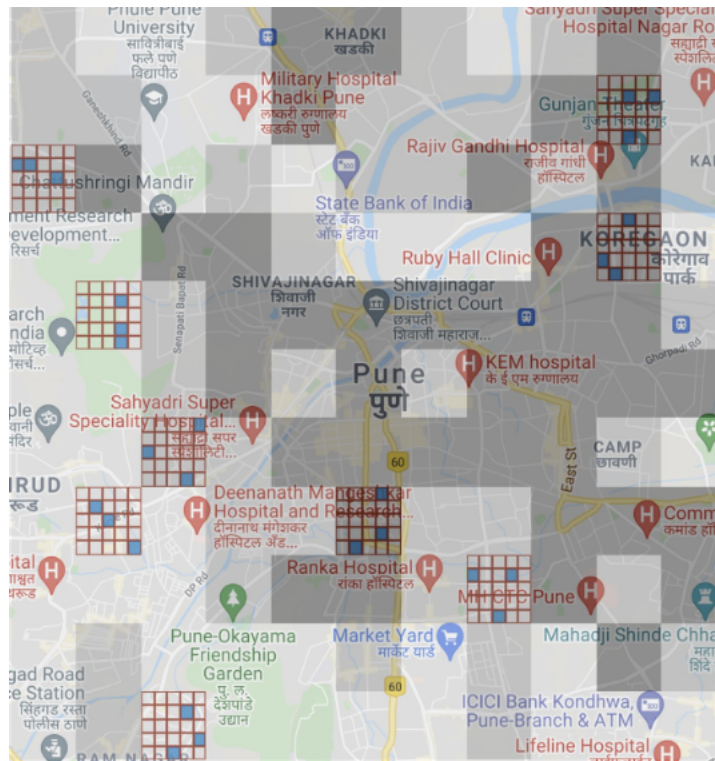
The Circularity Informatics Lab at the University of Georgia developed CAP in 2018, which is a standardized assessment protocol used to collect community-level data to inform decision-makers. The CAP characterizes seven community components:

1. **Inputs** — What products are sold in the community and where do they originate?
2. **Community** — What conversations are happening and what are the stakeholders' attitudes and perceptions?
3. **Product design** — What materials, formats, and innovations are found in products, particularly packaging?
4. **Use** — What are the community trends around the use and reuse of product types?
5. **Collection** — How much and what types of waste are generated? How much is collected and what infrastructure exists?
6. **End-of-cycle** — How is the waste disposed? What is the fate of waste once it is properly discarded? How is it treated?
7. **Leakage** — What waste ends up in the environment? How and why is it getting there?

Various influencing factors drive this system including governance, economics, policy, and legislation (e.g., bans, taxes). Furthermore, multiple stakeholders exist at every level of the CAP influencing the complex system, and these include the public, government, industry, NGOs, consumers, and academia. While the hub and spoke model illustrates the CAP, it is a complex system with components inherently interconnected to each other and life cycle impacts beyond each spoke. The CAP is a framework approach to the flow of materials, in this case focusing on plastic and packaging, and the quantity and characterization of leakage from this sector will be characterized during litter assessments that can inform upstream interventions in the rest of the systems model. As of early 2021, CAP has been conducted in 26 cities in ten countries.

This report documents work conducted by the Circularity Informatics Lab at the University of Georgia (UGA) and CEE as part of the Urban Ocean Initiative. Background information and a literature review were conducted in September 2020. Fieldwork was conducted from October 2020 – March 2021. The CAP report is split into the following sections, which include results and discussion of each: Input, Community, Product Design, Use, Collection, End of Cycle, and Leakage, followed by Opportunities to support the forthcoming Opportunity Assessment Workshops for Urban Ocean cohort cities.

Figure 1: Map of the 10x10 km sample area within Pune.



Population counts are shaded in gray. The 1 km² sample areas for product data are shown in red and 200m² areas for litter transects are shown in blue.

CAP Results

Input

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering Pune, samples of common convenience items were sampled within nine 1km² transects in Pune—three within each tertile of the population count. The LIP selected three convenience or grocery shops to sample within each 1km² transect area.

Figure 2: Shop surveys in Pune



(Photo Credit: CEE)

For each of the top products documented, the LIP noted the type of packaging (including polymer, if possible), the brand, and the parent company. From there, the team was able to determine the manufacturing location, which was determined from manufacturing locations listed on product packaging or desktop research, as well as the headquarters location for the parent company of the brand (largely determined by desktop research). The category of 'tobacco products' included all convenience items that contain tobacco, including cigarette, cigar, and tobacco sachet/gutkha products.

Table 1: Most Popular Plastic Product Distances to Parent Company Headquarters and Manufacturing Facilities

| | Distance Store to Parent Company (km) | | | | Distance Store to Manufacturer (km) | | | |
|------------------|---------------------------------------|---------|---------|--------|-------------------------------------|---------|---------|--------|
| | Minimum | Maximum | Average | Median | Minimum | Maximum | Average | Median |
| Beverages | 0.23 | 1686 | 1112 | 1526 | 0.23 | 1680 | 540 | 693 |
| Candy | 69.47 | 1553 | 519 | 467 | 0.23 | 2188 | 719 | 528 |
| Chips | 0.23 | 1608 | 856 | 715 | 0.23 | 1764 | 293 | 52 |
| Tobacco Products | 69.47 | 5052 | 1829 | 1588 | 136.42 | 5052 | 1874 | 1605 |

Note: Distances were projected using an Azimuthal Equidistant projection. Values have been rounded to the nearest km.

The majority of manufacturers and a large number of parent companies of most popular convenience products found in Pune are located domestically. All of the parent companies and manufacturing locations for top beverage, candy, and chip products were within 2,200km of the city of Pune. Of the products sampled, only eleven had parent company locations outside of the country – one tobacco product in a plastic-coated paper box manufactured in China, and ten tobacco products in plastic-coated paper boxes manufactured in the Philippines. These eleven products parent companies are also located in the same country as their manufacturing plant. All of the chip, candy, and beverage products had parent companies that were based within India. Manufacturing locations were also all located within South Asia, and all of the beverage and chip manufacturers were located within India.

Figure 3: Map of Parent Company Locations for Top Convenience Brands in Pune

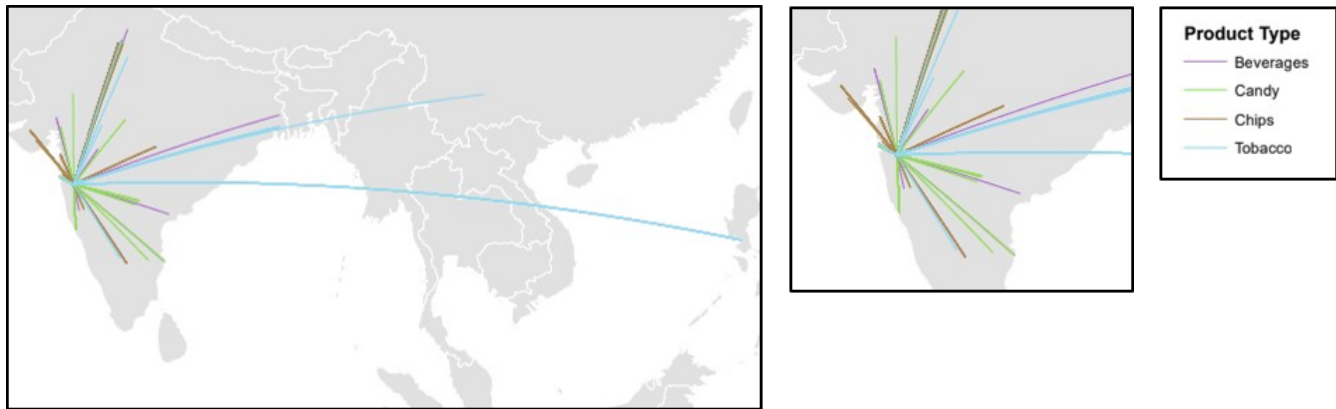
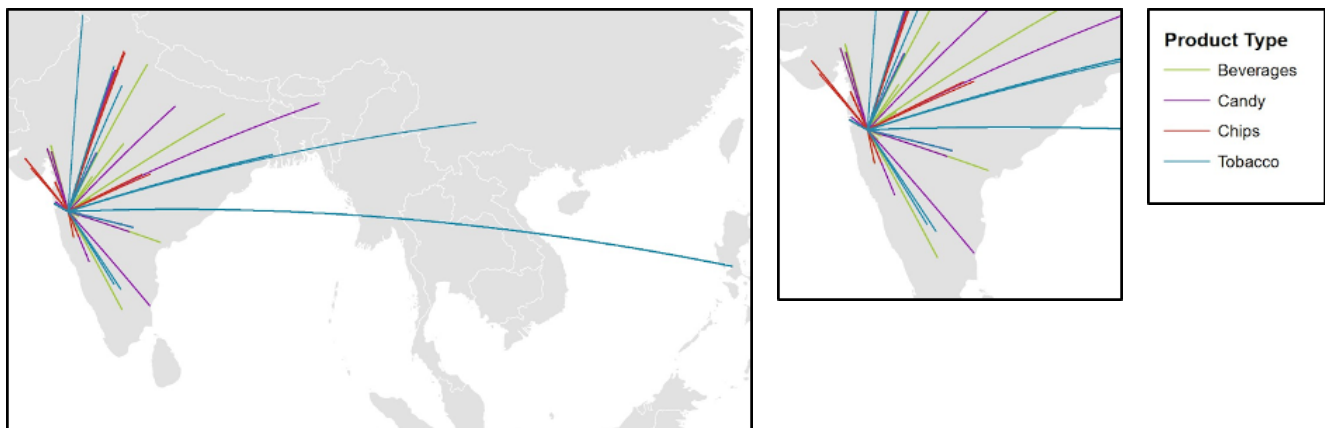


Figure 4: Map of Manufacturing Locations for Top Convenience Brands in Pune



The average distances observed between sales locations in Pune and the corresponding parent companies and manufacturing plants for top products were the smallest observed in Urban Ocean Cohort 1 cities to date. India is a major hub for supply chains, subsidiaries, and commerce and there could be a unique opportunity to support Extended Producer Responsibility (EPR) domestically. EPR was raised as a priority in stakeholder interviews as well as for local government in Pune and was listed as a key activity within the Pune Resilience Strategy (Resilient Pune 2019). The CAP Input data could be useful in supporting efforts for EPR locally, particularly for items that are most problematic in terms of waste management and litter such as film packaging and tobacco products.

In October 2020, SWaCH conducted a brand audit of Pune’s plastic waste from 1,000 households in the city. The audit featured plastic waste from one day of SWaCH collection that included waste generated from a Sunday to Monday and covered a mix of low-, middle-, and high-income households. The data revealed that Nestle, Coca-Cola, and Unilever were the top international brands contributing to Pune’s plastic waste (by number of waste items). Chitale Foods, Amul, and Gokul were found to be the largest domestic brands contributing to Pune’s plastic waste, largely from single-use milk packets. Overall, Chitale Foods was the most common brand found in Pune’s plastic waste for the audit, which is headquartered in Sangli in Maharashtra, India (SWaCH 2020, press release). A full list of manufacturers and parent companies identified through this study (CAP) can be found in the Appendix.

Community

To understand current attitudes and perceptions of plastic waste, semi-structured interviews were conducted by CEE with 24 key stakeholders (Table 2).

Table 2: List of Stakeholders Interviewed for CAP

| Stakeholder Group | Number of Interviews |
|---|----------------------|
| Academia | 3 |
| Companies Using Plastic Alternatives | 3 |
| Grocery or Convenience Store Staff | 3 |
| Hotel Industry | 3 |
| Informal Recycling Aggregator | 3 |
| Local NGOs | 3 |
| Local Government | 3 |
| Private Waste Hauling, Landfill, or Recycling Companies | 3 |
| Waste Pickers | 3 |

Several overarching themes and barriers emerged from the stakeholder interview process. In general, many of the interviewees expressed that single-use plastic had become ubiquitous throughout Pune and that alternatives were not only unavailable but also undesirable by the general public. Incentives, convenience, and cost were raised several times by consumers and business owners alike as factors that severely hamper or encourage the use of reusable or alternative items. General frustration, as well as specific issues related to efficiency and transparency with the formal waste system in Pune, were also identified, and many interviewees had recommendations for solutions. Disconnects emerged between the local government and the community, between the government and the informal waste sector, and between the different sections of the formal and informal waste sector. Many suggestions and recommendations were made regarding waste issues and methods to improve communication and efficiency within the city.

There was a sentiment from some community members that plastic usage, driven largely by globalization and a push to increase manufacturing from large corporations, is now a more popular choice than traditional systems of reuse or non-plastic alternatives, such as newspaper wrapping or metal plates.

“There was a whole cycle of use and collect in place and tempo or pickups would come and pick these bottles up for recycling. Now we replaced that cycle with plastic.”

— Academia

“Now every milkman tells you to keep your bags. That's the way it is now.”

— Business Owner

Stakeholders also expressed concern with the effects of plastic accumulating in particular areas, notably along the river. Some mentioned that cleaning up these dense areas of litter accumulation might prevent further disposal of waste in those areas in the long term.

“It's observation that if there are long weekends, say, on New Years, Christmas, Diwali, any kind of celebrations then there are bound to be huge amounts of plastic found in the river banks in those days. This is a subject of stress for us.”

— Business Owner

“All the chronic (litter lying area) spots must be cleaned... Half of the garbage is thrown in the river.”

— Grocery Store Owner

Even when waste is collected, challenges still exist across the waste management system. These include gaps between households and waste collectors in terms of timing and between households and waste processors in terms of waste segregation. This is discussed in more detail in the Collection and End of Cycle sections below. Challenges with waste collection also exist due to broader infrastructure issues, such as the general lack of services available in informal housing developments and road congestion.

“Because the slums that were built did not have the infrastructure or access to water, waste management in the house or garbage collection, they'd just chuck their waste behind the house, and the backside is the river. This was happening with great intensity.”

— Business Owner

The informal sector plays a key role in both waste collection and recycling in Pune; however, waste collectors are typically paid by each household, so there is competition to maintain a larger territory than might be practically serviceable by one individual. There is some discussion of providing an increased formalization of the informal sector, which would include providing improved personal protective equipment. There are, however, mixed sentiments on the process of formalization that range from seeing it as a necessity to seeing the obstacles as making it nearly impossible. The lower socioeconomic status of waste pickers is likely influencing this discussion along with current

interactions with more formal, government-led waste management efforts. The informal and formal waste sectors have their own discord, which is discussed further in the Collection and End of Cycle sections.

Figure 5: Photo from Waste Picker interviews, CEE



“In last few years, big people like contractors, corporators, Amdars (Members of the State Legislative Assembly) have started their own waste collection services and they are a competition to us. If we manage to get residential societies to pay us user fees, these big people reach out to the residential societies and offer services at lesser fees [or no fees]. So they have really become our competitors, and they are taking away our livelihoods.”

— SWaCH Waste Picker

“I think they should formalize some things in the informal system. If everything is normally formalized, then they should be trained.”

— Business Owner

“It is not logically possible to integrate the informal system...”

— Business Owner

“Most of the recycling industry works in the informal section so the formalization of it is a must.”

— Business Consultant

On the processing side, both informal and formal workers face challenges when it comes to segregating waste, which interviewees noted as the most time-consuming part of the waste management system. There is competition between these two groups, with valuable recyclables not entering more municipal waste streams because they are captured by the informal sector. Meanwhile, for informal recyclers, one of the largest constraints seems to be sorting space.

“On the other hand, there are many processing plants, but they are not getting the material they want, so they are going so far for the material.”

— Business Owner

“But the buyer wants to collect the paper only when 500 kilograms is available, which is economical for transportation. However, my shop is 10 x 10, and it would take a long time to collect 500 kilograms of paper, for which there is no space either. The buyer then makes an offer to buy the paper for 10 INR/kg, whereas the market rate is probably 20-30 INR/kg. I, therefore, yield and agree to sell at 10 INR/kg since I do not have the space to store 500 kilograms of paper.”

— Waste Collector

“There is no space for us to sit down and work. So we have to keep our recyclables in some un-used niches. Sometimes dogs and cats spread the collected waste on the footpaths, so we have to clean that first and then go for door-to-door waste collection work.”

— SWaCH Waste Picker

In terms of solutions to plastic pollution, there is much discussion of plastic tracking and extended producer responsibility to improve accountability of plastic manufacturers to connect them to waste management on the ground. The emphasis on EPR at the manufacturer level extends even to store owners who are selling plastic products. It is therefore unsurprising that buyback or deposit schemes were suggested by several stakeholders as a potential intervention.

“It will take multi-generation efforts to deal with plastic in such a way that we can track every piece of the plastic & bring it back in the circular economy.”

— Business Owner

“A better transparent system and view over who is producing the

plastic? And how the whole plastic movement is happening? There is no transparency and accountability in that whole system right now."

— Business Consultant

"We should find a way to legislate that the barcode should have the weight and type of plastic information... So if it is sold, it has to be accounted for it."

— Business Owner

"The manufacturer is responsible [for plastic waste]... Since the manufacturer make it, I buy it and give it to my customers. If they don't make it, I can't buy it and give it to my customers."

— Grocery Store Owner

"We have to create such a system that when you buy chips, you have to keep a deposit to bring them back. 5 rupees for a packet. Otherwise people do not appreciate its worth. It has to be mandatory for every shopkeeper to give back 5 rupees for that."

— Business Owner

On the community side, there is a discussion of awareness being a key to reducing plastic pollution, and some positive momentum with local organizations educating citizens was cited in interviews.

"Awareness [in] the long term is the only real change."

— Business Owner

"We also have started zero-waste composting groups in which we are training the people of the society in terms of how to compost, recycle and do recycling. We have trained a lot of people,... A lot of people have done this implementation too and it has been very successful. This has been a very good experiment."

— Business Owner

"We must teach the next generation what all can be done with waste."

— Waste Collector

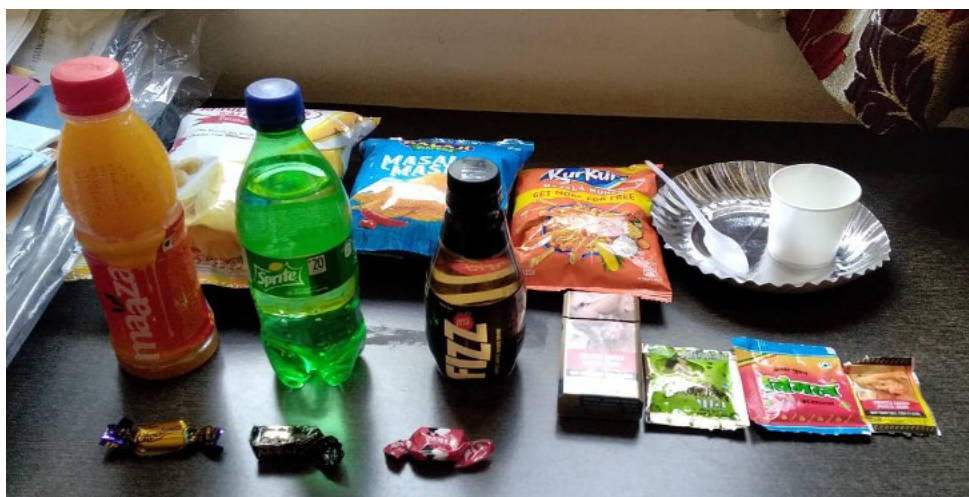
Government, private sector, and NGO initiatives alike were all mentioned during stakeholder interviews. There is a concerted effort being made in Pune to address the waste collection, management and to move towards the Zero Garbage Model that it is developing. However, the degree to which those initiatives are implemented, enforced, understood by the general public, and are most effective based on the local contexts and needs varies. Pune has a

strong opportunity to capitalize on current strategies and momentum to increase public awareness and to optimize its waste management system.

Product Design

To characterize material types used in common consumer products, samples of common convenience and to-go items were obtained as described in the Input section. The LIP collected samples from stores and restaurants when they were located in each of the nine 1km² transect areas where possible. The average weight of both the packaging and the product itself was collected for all of the 258 samples of top items from 47 grocery and convenience stores.

Figure 6: Convenience and to-go items collected from a transect area in Pune



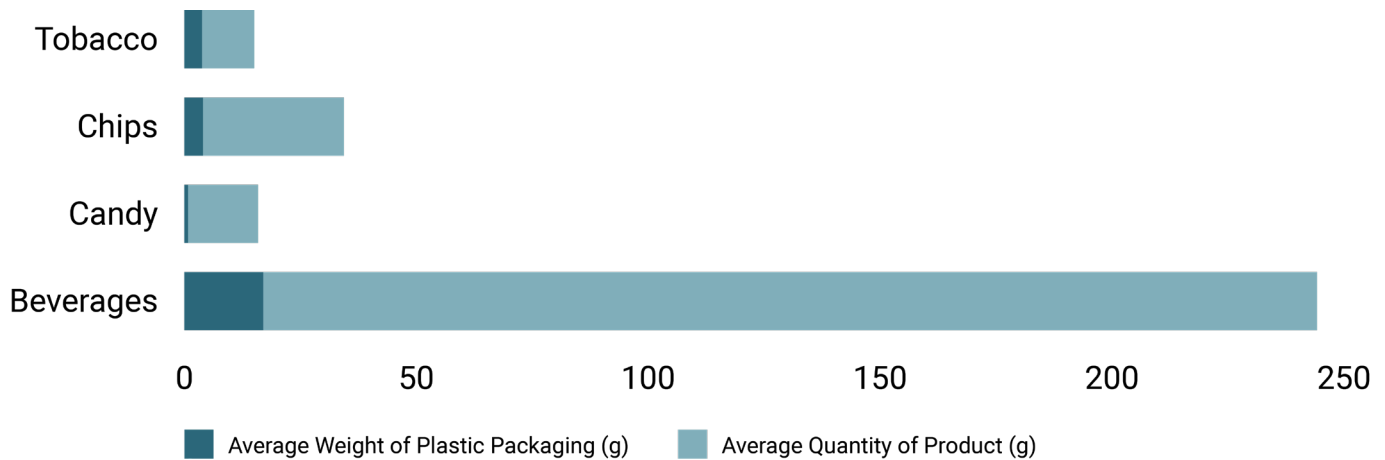
(Photo Credit: CEE)

Table 3: Average weight of products and their plastic packaging for common convenience items

| Product Type | Number of Samples | Average Weight of Plastic Packaging (g) | Average Quantity of Product (g) |
|------------------|-------------------|---|---------------------------------|
| Beverages | 67 | 17.0 | 227.2 |
| Candy | 72 | 0.8 | 15.1 |
| Chips | 76 | 4.0 | 30.4 |
| Tobacco Products | 43 | 3.8 | 11.3 |

Beverage products had the highest packaging and product weight on average, though tobacco products had the highest ratio of packaging weight to product weight. Tobacco products also had the smallest product weight overall. Candy products had the smallest average weight of packaging by nearly tenfold and also had the smallest ratio of packaging weight to product weight.

Figure 7: Convenience Store product to packaging ratios



(shown in grams)

The majority (59%) of top convenience items were packaged in multilayer plastic, followed by PET at 21% and a combination of paper and plastic, such as cardboard cigarette boxes wrapped in plastic film, at 15%. Among all beverage products, 80% were packaged in PET, which is typically high-price polymer for recycling. Another 15% of beverage products were packaged in Tetra pack, while only one beverage item was found packaged in each aluminum, recyclable paper carton, or multilayer film, respectively. It was found in the store surveys that 100% of top candy and chip products were packaged in multilayer plastic film and 100% of the tobacco products were packaged in a plastic-coated or plastic-wrapped paper box, all of which hold little to no value in the informal recycling economy in Pune.

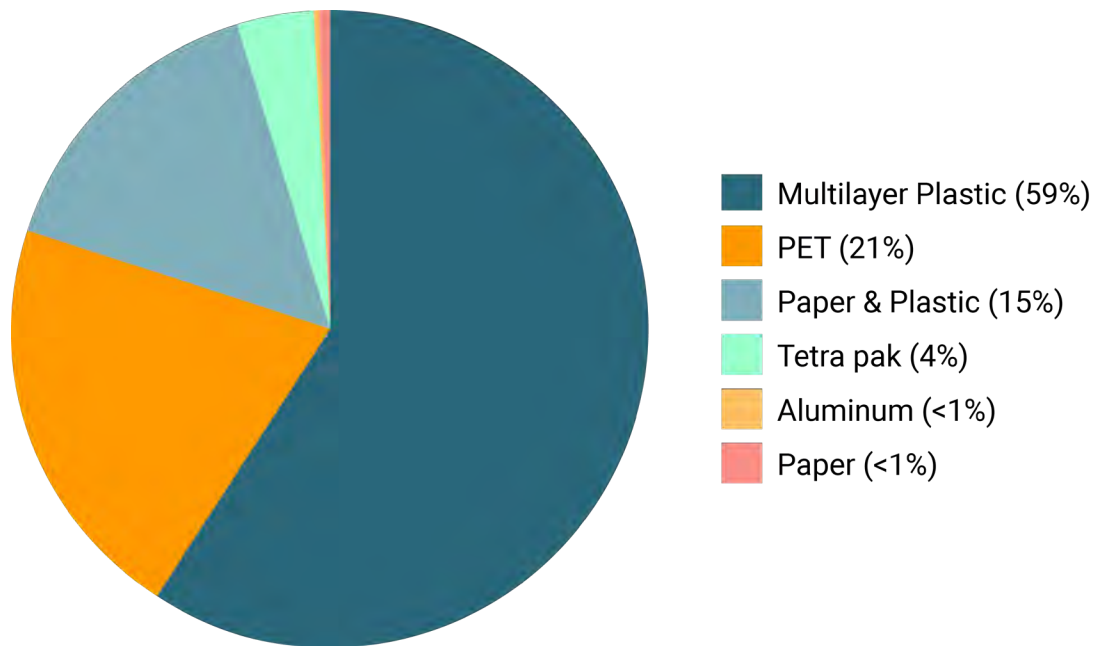
“If there will be a ban on single use plastic, this may not have a major impact on us as there is not much resale value to low-grade plastic.”

— SWaCH Waste Picker

A brand audit of plastic waste collected by SWaCH in October 2020 found that milk packets made primarily of LDPE comprised a significant amount of the household plastic waste stream in Pune. There are several potential explanations for why these products did not feature as prominently in the CAP data collection. The most common convenience brands were defined as either the most often purchased according to the shop owner, or — if that information was not readily available — based on the amount of shelf space that the product has in the store. The LIP reported that milk sachets are not always as visible in grocery stores, particularly compared to soft drinks that often have their own branded refrigerators displayed prominently in the store. Not all grocery stores in Pune sell milk packets, and they are often sold in specialty milk and dairy product stores — which were not included in the convenience and gro-

cery store surveys—or they are sold through small milk stalls that are only open for 2-3 hours in the mornings. The LIP also noted that many households get their milk delivered as opposed to purchasing from stores in Pune.

Figure 8: Material Breakdown of Top Convenience Items in Pune



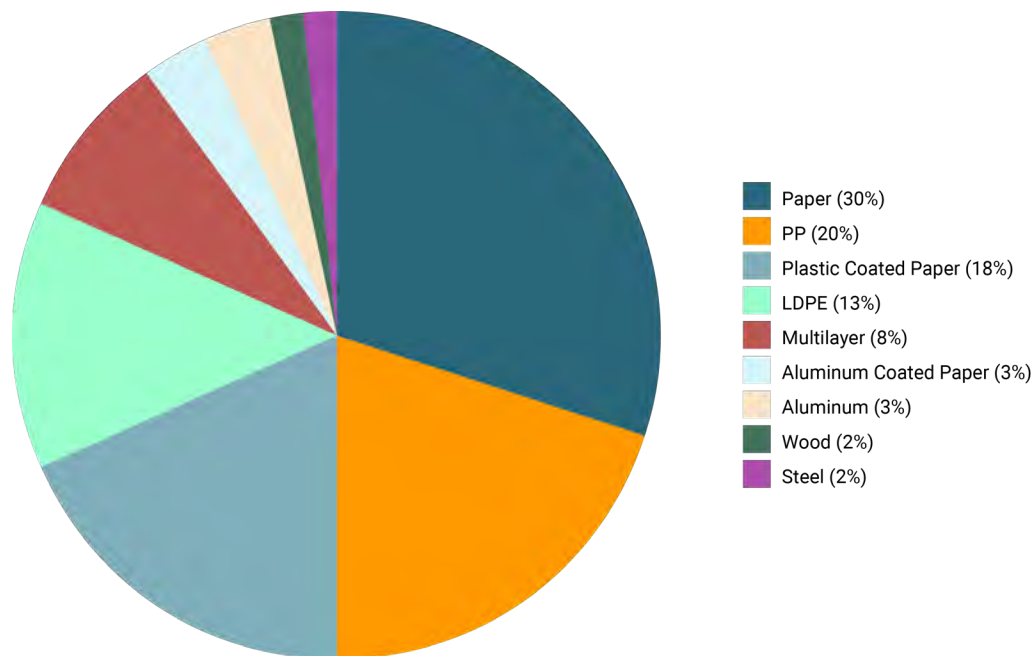
Within each of the selected nine 1km² transects in Pune, the LIP also visited up to 3 randomly selected food vendors or to-go restaurants to sample the food packaging and utensil types that were being distributed, totaling 26 vendors sampled. The LIP collected 60 to-go items from those vendors and documented their weight, material type, and brand, where possible.

Table 4: Average weight of common plastic packaging items from food vendors

| Material Type | Number of Samples | Average Weight of Packaging (g) |
|---------------------------|-------------------|---------------------------------|
| Paper Bag | 10 | 8.6 |
| Plastic Bag (LDPE) | 8 | 2.6 |
| Paper Cups (mostly tea) | 8 | 2.0 |
| Plastic-coated Paper Cups | 2 | 2.0 |
| Multilayer Plate | 4 | 2.8 |

| Material Type | Number of Samples | Average Weight of Packaging (g) |
|--------------------------------------|-------------------|---------------------------------|
| Plastic-coated Paper Plate | 4 | 2.8 |
| Aluminum-coated Paper Plate | 2 | 2.5 |
| Plastic Cups (PP) | 1 | 1.0 |
| Plastic Spoons (PP) | 11 | 1.6 |
| Wooden Spoon | 1 | 2.0 |
| Multilayer To-go Container | 4 | 2.5 |
| Plastic-coated Paper To-go Container | 2 | 2.0 |
| Aluminum To-go Container | 2 | 3.0 |
| Steel To-go Container | 1 | 0.0 |

In contrast to the pattern seen in the top convenience items, the most common material found in to-go items sampled (30%) was paper, mostly in the form of to-go tea cups and to-go paper bags. Among the items sampled, 72% of the cups and 37% of the bags were made of paper. Plastic materials were most commonly found in disposable utensils, disposable plates, and around 58% of to-go bags. Among the four food containers that were sampled, half were made of plastic and the other half were made of aluminum or steel — however, it was noted anecdotally in interviews that the prevalence of metal to-go containers is almost negligible in Pune.

Figure 9: Material Breakdown of To-Go Items in Pune

Among the food vendors and restaurants sampled, it appears that the College Food Court and the Sweet Marts most often distributed to-go items that were made of plastic alternative materials. In contrast, the casual restaurants and Snack Centres distributed to-go items that were mostly made of single-use plastic.

Use


Even though Pune had many alternatives to plastic provided by food vendors (majority paper) they were rarely brought up in the stakeholder interview process, and reusable or refillable items were not observed in surveying during fieldwork. It was mentioned in the interview process that there were a few start-up and pilot programs that were offering refillable containers and delivery services in Pune, such as Country Delight milk products, but they are not ubiquitous within the city.


Figure 10: Container Deposit Schemes in Pune

BUYBACK PLASTIC

- Milk Dairies, retailers and sellers provide
- Rs. 0.50 per bag as refund on return.
- PET or PETE bottle manufacturers, producers, sellers and traders to provide Rs. 1 or 2 per bottle as refund on return

Milk Dairy and distributors shall make efforts to develop alternative system with glass bottles or any other environmentally friendly material for distribution of milk.





DWSM 2021

Community interest in alternative options to plastic, in general, seemed mixed. There were, however, many references to the historical use of plastic alternatives and reusable items, and that this was once the normal practice in Pune. As discussed in the Community section, increased plastic production and use by large companies, globalization, and lifestyle changes were cited as reasons for the increased use of plastic packaging. In addition, no viable alternatives, and a lack of interest among the public for those alternatives, were also reported.

“When we bought a bicycle it was wrapped with newspaper; nowadays everything is wrapped in plastic. They are producing it unnecessarily. They want to increase manufacturing; thus they are increasing the packaging.”

— Business Owner

Interviewer: “20-30 years ago people used to bring a steel can or a bottle for buying oil?”

Grocery Store Owner: “Yes, they used to bring bottles as well.”

Interviewer: “Do you know someone who does that type of thing now?”

Grocery Store Owner: “No, none. No one does that now.”

Many mentioned that this trend of more packaging, more single-use items, and more plastic associated with everyday items have also led to difficulty and confusion in waste collection, disposal, and management in Pune. It has also made single-use plastic items and packaging largely unavoidable.

“We have started to use the various plastic commodities for different uses more now

as compared previously. There are new components coming in view with the increased use of plastic that it has become more difficult to segregate them and even avoid it."

— Business Consultant

The government instituted a plastic ban, which was not strictly enforced, so it was mentioned several times by interviewees that the standard practice has now returned to disposable plastic items. Many also noted that people in fact prefer disposable plastic items now because of their convenience, availability, and low or no cost.

"But once the strictness, turgidity [of the plastic ban] was overseen ... the working relaxed, people came back to their initial medium of work. Why? Because there is no good alternative available for [plastic,] if [there] was, people would naturally go for the alternative."

— Business Consultant

"Now [people] don't want steel plates, they want plastic plates ... Bottles also came back ... What this means is that there is no substitute for plastic."

— Government Worker

Economics was mentioned frequently as a factor in the decision of whether or not to use plastic. Some cited the cost of supplying disposable carry-out bags as a justification for requiring customers to bring their own bags and ultimately save the company money:

"When I met the shopkeepers, they said that it costs them 500 to 5,000 rupees to buy carry bags. If customers carry their own carry bag then it saves them 5,000 rupees. They all very happily wanted to follow it. Then one [customer] stopped carrying his own carry bag and the shopkeeper said that if there is no carry bag, they can't sell him goods. He'll have to go some other place for his shopping. It was a strategic decision."

— Business Owner

Others were skeptical of this tactic, and worried that providing plastic alternatives or requiring customers to bring their own bags—while it would save the company the cost of purchasing plastic bags and may help curb pollution—would ultimately lose them business because of consumer perceptions:

"If you go and see every vegetable vendor almost spend 3000 rupees on plastic every month, they use it too, imagine if they save 1000 for every month for per shop, how much it will be there. If every vegetable vendor saves Rs. 1000 per month by using an alternative to plastic, imagine how much benefit it will be. But they will not do it because the customer may not be willing to buy from them."

— Business Owner

Some business owners were very frank that the cost difference alone between paper and plastic was not significant to them, but that the convenience associated with single-use disposable plastic items was the determining factor:

“Neither paper nor plastic is too expensive for us ... [plastic] takes less time.”

— Grocery Store Owner

It is worth noting that of 25 convenience stores surveyed in Pune, 14 (56%) did not offer bags to customers, and one store offered a reusable carry-out bag. All other stores offered single-use plastic to-go bags.

Interestingly, it seems from the stakeholder interviews that the citizen or consumer sentiments in Pune on the issue of plastic use and alternatives are varied, at least from the perspective of the business owners that they purchase from. There was not an overwhelming consensus on consumer behavior or attitude towards the availability of alternatives.

“[Customers] don't care [about the plastic problem]. They ask for two plastic wrappers instead of one”

— Grocery Store Owner

“[My customers] were happy [about less plastic]. My oil boxes are [made] of metal and the waste bin has been empty for 3 days. There were 250 gms of bottles coming in.”

— Grocery Store Owner

Another question that was raised during the stakeholder interview process was over responsibility for the plastic problem, specifically alternatives, and who that ultimately belongs to in Pune. While many seem to feel that the government is responsible for action to prevent waste, a general sentiment of frustration with the pace or lack of clear initiatives from the government to improve waste collection and management was reported.

“The initiatives between [solid waste] Management and Pune can be said from the beginning that they are awkward.”

— Business Owner

“Wherever there is a bin, there is waste. We have spoken multiple times with the PMC, but it does not work out. They do not understand that it is a major problem. Many chronic (litter area) points have been in the same manner for the last 10 years... We have had so many meetings, but the situation has not changed. There has been no result in spite of doing so much with PMC and Swacch.”

— Grocery Store Owner

“The government has tried to ban plastics, but has there been any big program to prevent plastics?”

— Business Owner

This perceived government inaction or lack of enforcement has led some local businesses to take matters into their own hands to curb their own plastic use. Many waste efforts in Pune are now led by businesses who find ways to provide reusable alternatives or to reduce or recycle their plastic waste. Several such initiatives were mentioned in the interview process.

“Donated saree was used for this. If someone passes away in a house, we collect their sarees [to make bags] ... All the neighboring shops and now 2 more shops buy the bags.”

— Grocery Store Owner

“They break down non-recyclable plastic like that of chips packets. Later, she set up a small industry in Daman and Diu, where she has employed local women to make plastic threads. Plastic means thread. After all, it is elastic. Plastic is nothing but an elastic. She makes purses and threads. She basically upcycles and creates goods.”

— Business Owner

“There are Sustainable Lifestyle Experience Centers. They collect all kinds of solid waste there and then they have also made a small instrument to crush tubelight [fluorescent light bulbs]. Otherwise, tubelight goes into the environment, which is very harmful.”

— Business Owner

“Sagarmitra collects plastic from us and recycles it. Rudra makes poly fuel out of it and they collect from the societies but societies have to be very big and plastic quantum is to be larger and they collect it from very selected places so their transportation cost could be cover.”

— Business Owner

While alternative and reusable options are still limited in Pune, it is worth noting the historical experience that was referenced in the interview process. It may be useful for the city to explore whether some of those reusable options and perspectives could be instilled in the community of Pune again, and what could be done to support consumer and business transitions back to the more traditional methods (although they can also be facilitated by technology). Some interviewees referenced refill and reusable options that are available in other cities in India, such as using a token system for milk bottle refill in Delhi, and would like to explore whether such incentive schemes may work in Pune. It is clear that local businesses do have a desire to make positive changes where and when they can, but there need to be incentives and viable options for them to pursue those changes with support from other sectors of society.

Collection

Solid waste collection, transportation, and disposal for both general resource recovery and formal recycling in Pune is the responsibility of the Pune Municipal Corporation (PMC). According to the jurisdiction of PMC, the city itself covers a 334 km² area (before the merger of 23 villages in June 2021) which is broken down into five Administrative Zones which contain three or four Wards each, which are further subdivided into Prabhags and further into Kothis. This hierarchical structure in total comprises 5 Zones, 15 Wards, 42 Prabhags, and 190 Kothis. PMC has a classification system that divides waste in Pune into 25 categories, with household waste comprising 69% of all MSW in the city by source (Sohkhlet and Nagargoje, 2020; DSWM 2021). There are an estimated 1.28 million properties in Pune, 1.22 million of which receive regular waste collection services (SWaCH monthly report, June 2021).

Figure 11: Public waste bin in the Kothrud residential neighborhood of Pune



(Photo Credit: CEE)

In terms of MSW collection, 70% is conducted via door-to-door collection (DTDC) by Solid Waste Collection and Handling (SWaCH), which is a cooperative partnership between PMC and Kagad Kach Patra Kashtakari Panchayat (KKPKP), a union of nearly 3,500 self-employed waste pickers in the city. Remaining waste collection is covered by community bins serviced by Dumper Placer trucks that transfer waste to the transfer stations and by “ghantagadi” (also known as “hourly trucks” or “bell-ringing vehicles”) that collect recyclable and non-biodegradable waste from households and buildings according to predefined routes by Prabhag. According to SWaCH monthly reports, SWaCH had a coverage of around 40% in 2016-2017. In 2017, the city of Pune’s jurisdiction was increased by almost 20%, and by 2021 SWaCH had increased its collection coverage to around 66%. Of the remaining amount, 23% is collected by PMC through gphantagadis, 5% by private collectors, and around 4% still remains uncollected (SWaCH monthly report, June 2021). However, in 2021, PMC reported that there was 100% DTD collection, 96% segregation rates, and 100% collected waste transportation in the city (DSWM 2021). It is worth noting that the partnership between PMC and SWaCH is on a 5-year contract renewal basis and is up for renewal in 2021.

Figure 12: Characterization of plastic waste collected

| Type of Plastic | % | TPD |
|---------------------------------------|-------|------|
| Colored Plastic Packaging (Mixed Men) | 47.75 | 79.4 |
| Chip bags and packets (Kurkure) | 16.37 | 27.2 |
| HDPE containers (Phuga) | 15.63 | 26.0 |
| Milk Bag (Doodh Pishvi) | 7.17 | 11.9 |
| Thick PET bottles (Kadkadi) | 5.34 | 8.9 |
| White high grade film plastic (LD) | 2.42 | 4.0 |
| Styrofoam (Tharmocol) | 2.11 | 3.5 |
| Tetrapak (Juice Dabba) | 1.21 | 2.0 |
| Small plastic pieces (Kadak) | 1.38 | 1.6 |
| Bicycle seats and Rubber Tubes | 0.34 | 0.4 |
| Cement bags (Rafiya) | 0.18 | 0.3 |
| PVC pipes | 0.08 | 0.1 |

DSWM 2021

According to the Solid Waste Management Department of PMC, as of 2020, there were an estimated 966,724 households within the city of Pune generating an average of 2,000-2,100 metric tons of waste per day total. It was reported in 2021 that there were 646 vehicles owned by PMC conducting waste collection in the city and 155 contracted from other private entities. Many of those vehicles are chhota hatti (248) and ghangtagadi (224), though this number also includes bulk refuse carriers (85), compactors (53), mechanical street sweepers (26), and other vehicles. It was also estimated that there were 847 containers and 116 compactor buckets dispersed around the city for general MSW collection and transportation needs, in addition to 123 e-waste and plastic collection centers located across the city (DSWM 2020; DSWM 2021; PMC 2021). In 2015, PMC reported that the household level coverage of solid waste management services in Pune was 80% and that the efficiency of collection of MSW was 100% (Kumar 2015). In 2021, PMC released an updated report stating that the extent of segregation of MSW had grown from 44% in 2015 to over 80% in 2021, and that the extent of scientific disposal of MSW (such as controlled landfill) had grown from 50% in 2015 to over 90% in 2021 (PMC 2021). Despite reported numbers, it was mentioned several times in the stakeholder interview process that capacity, space, and resources in Pune present a barrier to effective waste collection and processing. Monitoring of the waste system in Pune, including statistics such as household numbers and collection coverage, is conducted monthly – however, this is conducted directly by PMC and SWaCH and not by an independent third party. The PMC and SwaCH collaboration seems to be accomplishing as much as possible with the limited resources that they have available.

“The problem with Swacch is that they neither have space nor vehicles. They have 4 boxes now. How will they take the waste in that?”

— Grocery Store Owner

“I have read that [waste pickers] should get gloves and a dress

[uniform clothing] which they are not getting. It is half a kilometer from Wakeshwar to Regent Plaza, so they need a vehicle to carry it.”

— Grocery Store Owner

“PMC is running out of manpower, because there is a shortage of people and they cannot afford it.”

— Business Owner

Pune was also the first city in India to implement the Adar Poonawalla Clean City Initiative in 2015. The private initiative provides resources and support to PMC, particularly on cleaning street waste and conducting outreach activities to schools and local communities. As of 2020, the initiative had provided over 200 trucks/machines and 400 employees to help cover around 60% of the urban area of Pune (APCCI 2020).

Figure 13: Example of Clean City Initiative bins near Koregaon Park Road in Pune



(Photo Credit: CEE)

In the stakeholder interview process, some expressed frustration over the processes and timing of formal DTDC waste collection in the city. One issue arose in situations where collection times coincide with times when people are typically not home. Another challenge was areas where households generally do not want their waste to sit indoors and so waste is deposited outside directly after cooking, sometimes three times per day — however, collection only occurs once per day, and cases like this have led to chronic dump sites. While there are processes and infrastructure in place, there appear to be opportunities that could maximize collection and make existing processes more accessible and convenient to the public in Pune.

“The big flaw we see is that these people who go to pick up the garbage do that in

the morning. They start picking up trash at half past six and they close at 3:30 in the afternoon. Those who work as maids in the houses leave early in the morning. When they come home, their waste is still here and is piling up. Since the container is removed from there, they can't dispose it anywhere. The garbage collectors keep ringing the bell, but nobody comes. That waste location then falls in the category of chronic spot."

— Business Owner

"Husbands and wives leave for work at seven or eight in the morning. You [DTDC workers] ring the bell at ten, eleven o'clock. Even if they want to, they can't put out trash."

— Business Owner

Pune has a decentralized, complex, and in some cases duplicative or overlapping system of waste collection and management. While SWaCH covers around 70% of the city and the rest is covered by PMC and various private entities, the distribution of those collection systems is very fragmented. It was reported in interviews that this fragmentation is caused in part by political or community opposition to paying user fees, especially where citizens have already had access to free waste collection service through PMC and where collection of user fees isn't enforced.

The lack of coordination between primary and secondary collection and transport seems to serve as a barrier to efficient waste management in Pune. It was reported in the interview process that, with multiple entities serving at multiple points in the waste flow process, can cause challenges. PMC does primary collection as well as secondary transport, both for PMC and SwaCH, and secondary collection and transportation can often be a bottleneck causing delays between primary collection and processing. This can lead to collected waste sitting outside for long periods of time, becoming contaminated, and ultimately decreasing the value of the waste and efficiency of the system. Of the PMC vehicles for dry waste collection that arrived late in June 2021, 15% cited that the vehicle conducting primary collection before secondary collection was the cause of the delay, and another 24% cited that the delay was caused by the driver changing the route without informing the rest of the collection chain. In terms of vehicle efficiency, 12% of delays for PMC vehicles transporting wet waste and 7% of delays for PMC vehicles transporting dry waste in June 2021 were caused by vehicles breaking down (SWaCH monthly report, June 2021).

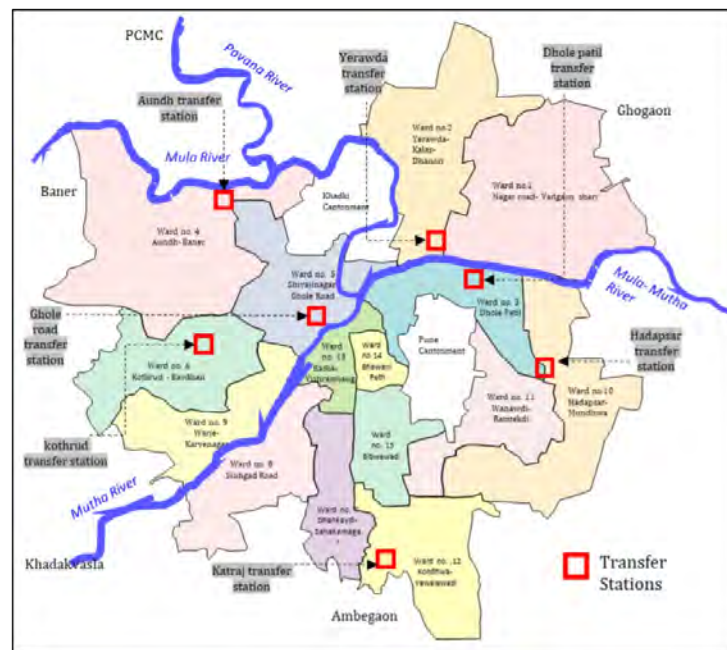
"Sometimes, when the secondary collection vehicle assigned to our area fails, we have to wait to clear waste, affecting our door-to-door collection. How can we collect waste from the next houses when our pushcarts are full, and the secondary waste collection vehicle is not there to empty our carts?"

— SWaCH Waste Picker

The allocation of resources for collection seems to be a challenge, with many of the existing vehicles going only to primary collection — when waste is collected directly from the household — and not enough being used for secondary collection and transport — where aggregated collected waste is transported for storage and processing. Another bottleneck in the system that was mentioned was the ramps for the transfer stations. It was reported that waste in Pune is often transferred from secondary collection directly into a bulk carrier, which is only able to make one or two

trips per day and has a strict volume and weight capacity. This leads to primary and secondary collection vehicles waiting for long periods of time (some in the interview process cited hours of waiting time) to be able to offload to bulk carriers. Of the PMC vehicles for dry waste collection that arrived late in June 2021, 19% cited long waits at the ramp as the cause of the delay (SWaCH monthly report, June 2021). One interviewee mentioned a potential solution from the city of Indore, where the ramps for transfer stations also act as temporary storage facilities, and a capsule takes the waste and puts it aside so that primary and secondary vehicles do not have to wait to offload their waste. Pune could explore options like this to optimize their collection and address some of the inherent challenges of a decentralized waste management system.

Figure 14: Map of transfer stations



DSWM 2021

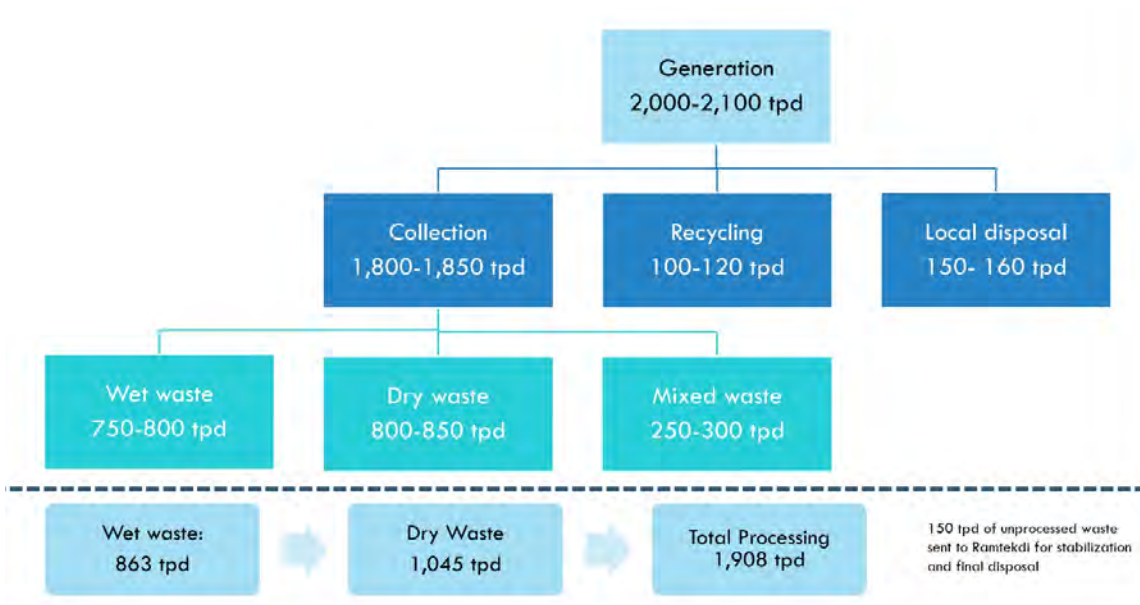
In 2020, it was estimated that around 12% of waste in Pune was collected by SWaCH and directly recycled, 9% was processed in-situ, 8% was diverted to farmers for composting, and 71% was sent to landfill (Sohkhlet and Nagargoje, 2020). Based on numbers released by PMC and SWaCH in 2021, around 62% of all waste collected by SWaCH is recycled (plastic is largely sent to Shakti Plastics), 22% is sent to PMC dry waste processing centers, 9% is processed via pyrolysis, and around 6% is sent to landfill (SWaCH monthly report, June 2021). It was reported in the stakeholder interview process that, while the improvement in processing capacity and technology is promising for the city, the hope is to also increase the amount of waste that is directly diverted to recycling by SWaCH. However, adequate sorting practices and sorting space are critical for this to happen. The SWaCH system depends on Pune residents paying user fees, which directly ties the income of the waste pickers to the value of recyclable items. If the system cannot be optimized, the value of recyclable items may decrease over time. Due to the decentralized nature of the waste collection structure in Pune, it is also difficult for waste collectors to have access to areas—ideally spread throughout the city—where they can safely sort waste that has not already been segregated and have access to short-term storage for recycling. It is estimated that only 1,000 of the current 3,500 SWaCH waste pickers in Pune

have access to sorting spaces, and there are reportedly 54 sorting sheds available for all primary collection in the city (SWaCH monthly report, June 2021).

“Collecting user fees is still a challenge. Citizen believe that we are paid by city administration. We have to spend lot of time to convince them.”

— SWaCH Waste Picker

Figure 15: Solid Waste Flow Chart for Pune



from Pune Office of Resilience, 2021.

Another key issue is segregation. While PMC reports segregation rates that have grown from 52% in 2017 to 96% in 2021 (PMC 2017; PMC 2021), this was still a theme throughout multiple stakeholder groups in the interview process. Feedback ranges from consumers expressing that segregation requirements weren't clear, to waste collectors who were losing profit because of improper household sorting, and even researchers and business owners who noted that the segregation process is convoluted and differs between formal and informal structures in Pune. Mandates on source segregation and open dumping that do exist are not well enforced.

“In terms of challenges [to formalization], when I had studied the scrap shop flowchart, it came to my understanding that the segregation by dustbins and segregation done by them [waste pickers] is different.”

— Business Consultant

“If it [waste management] is done properly if the garbage does not fall outside the house, then the concept of waste picker will be obsolete. Why should someone else pick up

your trash? This concept should be ended first. If you want to introduce any system, the most important thing is that the government should work on source segregation.”

— Business Owner

“Since there is no control over that dry material collection, it will always be problematic, if your approach is not clean, if your technology is not so flexible, then today it has become more [troublesome]... You can only control the raw material so much that it should be easily segregated.”

— Government Worker

“Earlier, when PMC had this cemented structure to dump waste, we picked only things we could sell to scrap dealers. Now as we are going door to door, we are collecting sanitary waste, huggies [sanitary waste/diapers], Thermocol [PS], which we can’t sell to scrap dealers, but still, we help the corporation in segregating it.”

— SWaCH Waste Picker

“Nowadays, citizens are giving us segregated waste. It’s not fully segregated but much better than when we started our work in these societies.”

— SWaCH Waste Picker

Waste collection in the slum areas was cited in the SWM Strategic Plan as well as in interviews as an ongoing challenge for Pune. In 2016, SwaCH covered around 15% of slum areas in Pune. At that time, a subsidiary was introduced whereby PMC would supplement payment to the waste pickers in slum areas, as they were not receiving user fees there. By 2020, SWaCH estimated that coverage in the slum areas has grown to over 70%— a higher percentage than the SWaCH coverage of non-slum areas in Pune (SWaCH monthly report, June 2021). However, for the remaining 30%, PMC does not have the capacity or adequate mechanisms to undertake collection there, and often the subsidiary amounts are still not sufficient to incentivize collection in slum areas, or the fees are simply not paid. This can create a vicious cycle that leads to less collection in slum areas and increased open dumping.

“We charge 50 rupees in slums and 70 rupees to other houses. All citizens can’t pay, some are elderly, some don’t have jobs. We don’t force them to pay, we understand they are not in position to pay. There are ten to twenty such households in my area [out of 120-180 households].”

— SWaCH Waste Picker

With multiple stakeholders and complexities in the collection system in Pune, awareness among residents is crucial for the system to function. Limited outreach programs and understanding among the general public in Pune around protocols for waste collection was mentioned in interviews as a major barrier to effective waste management. Inter-

viewees mentioned that there is no general training for staff that work in waste collection and management as to what is recyclable, why user fees are beneficial for the city, effective ways to compost, and other messages that would be useful to understand if they were asked by users. It was noted by one interviewee that an NGO was appointed in 2017 to serve as a conduit between PMC and the citizens of Pune, engaging in activities such as door to door outreach on segregation, third party monitoring of collection systems, and reporting. That system no longer exists, and outreach appears to be most often through Twitter, WhatsApp, and public banners on streets. For SWaCH, the only face to face interaction is through the waste pickers themselves, and it was mentioned that they would benefit from a third party that could help with outreach and awareness raising. In particular, topics such as the benefits of user fees and the importance of source segregation are difficult ones to effectively communicate and require extra support. There could be a tremendous opportunity to reinvigorate public outreach by a third party that has a partnership with PMC and SWaCH, and to clarify for the public how all of the entities in the waste network (including themselves) need to work together in the system.

There are a wide range of initiatives in Pune that have been developed in the last few years to try to tackle issues surrounding litter and hard-to-recycle items. As mentioned above, the vast majority of top consumer products in Pune are packaged in multilayer plastic film, which is difficult to segregate, collect, and recycle. To address this issue, PMC and SWaCH launched a partnership in 2019 with ITC Limited, a top consumer brand in India, to incentivize collection of multilayer plastics and other low-value plastic items. ITC was also the brand for many of the consumer products sampled in the CAP (see Appendix). Through this model, waste pickers can collect and sell multilayer plastic directly to PMC at a rate of Rs.4 per kilogram. The waste is then stored in a PMC facility, eventually transported to the SWaCH Plus-ITC Sorting and Baling Facility in Uruli Devachi, where it is ultimately baled and sent to recyclers, plastic-to-oil plants, and other end-of-life processors of plastic waste in accordance with Plastic Waste Management Rules of 2016. The Sorting and Baling Facility reportedly has a capacity to manage up to 150 MT of low value plastic per month. As of April 2021, the initiative had collected 741 tons of low value plastics, integrated 1,000 of an estimated 3,500 waste pickers in Pune, and provided service to 11 of 15 wards in the city. This type of model could be beneficial to scale as a sustainable model to address the ongoing challenge of low value and difficult to recycle plastics (SWaCH 2021).

SWaCH and PMC also launched the V-Collect on Wheels program in Pune in 2020. The aim of the program is to collect and reuse household items in Pune that are would otherwise be likely to end up in landfill, such as books, toys, household items, electronics, and furniture. The program was marketed as a way to both increase recycling and help people to more easily declutter their homes (Parekh 2020). As of 2021, it was estimated that the program collects on average around 25 metric tons of items every month — 13.8 tons for June 2021, as an example — the majority of which is reused or recycled (SWaCH monthly report, June 2021).

Another example of innovation in Pune to incentivize collection of low value plastics the “RecyCole” partnership. This is a program between K.K. Nag Pvt. Ltd and SWaCH, with support from PMC, that is launching in August 2021 to address collection of expanded polystyrene. K.K. Nag Pvt. Ltd has imported and installed machinery at its facilities in Urse Village and Ranjangaon that is able to recycle expanded polystyrene back into expanded polystyrene using 20% of the waste material. The machinery is reportedly currently collecting over 1.5 tons of expanded polystyrene every month. Through this planned partnership, SWaCH waste collectors will collect expanded polystyrene — which they have not done in the past due to its low value and lack of processing ability — and the material will be aggregated at PMC’s secondary waste collection system and waste transfer stations, then collected by K.K. Nag for recycling

(RecyCole 2021). This serves as another example of an initiative that could potentially be scaled and expanded upon, and the city should closely monitor its inputs and outputs in the coming months following the formal launch.

SWaCH in Pune also launched the “Red Dot Campaign” in 2017, which promotes segregation and collection of sanitary waste in the city. SWaCH collects and segregates an estimated 20 tons of sanitary waste every day, which is an occupational and health hazard. The campaign promotes the segregation and marking — with a red dot — of household sanitary waste, so that waste pickers know that it needs to be handled differently. That waste can then be sent directly to a waste to energy plant (Agarwal 2017). In June 2021, the program collected 2.6 tons of segregated sanitary waste from 591 feeder points in the city (SWaCH monthly report, June 2021).

In the SWM Strategic Plan 2017-2025, the city of Pune identified several key gaps in waste collection, many of which mirrored frustrations and concerns expressed through the stakeholder interviews (PMC 2017). While some gaps have been addressed in the years since 2017, challenges such as those described above remain an issue for the waste sector and residents of Pune. Additional barriers were identified in the Strategic Plan related to technology and monitoring capacity, including challenges with newly installed GPS trackers on collection vehicles in an attempt to increase transparency and availability for collection, as well as qualified technical staff to support monitoring of transfer stations and collection systems operations (PMC 2017). As of June 2021, it appears that the PMC online tool for the GPS trackers on the collection vehicles is still not fully operational, though the PMC successfully tracks a wide range of data related to the weight and types of waste in the city.

“And the other [trucks] are not working efficiently. You just put GPS in [them] and no one is monitoring it, so I don't know if it's working or not.”

— Business Owner

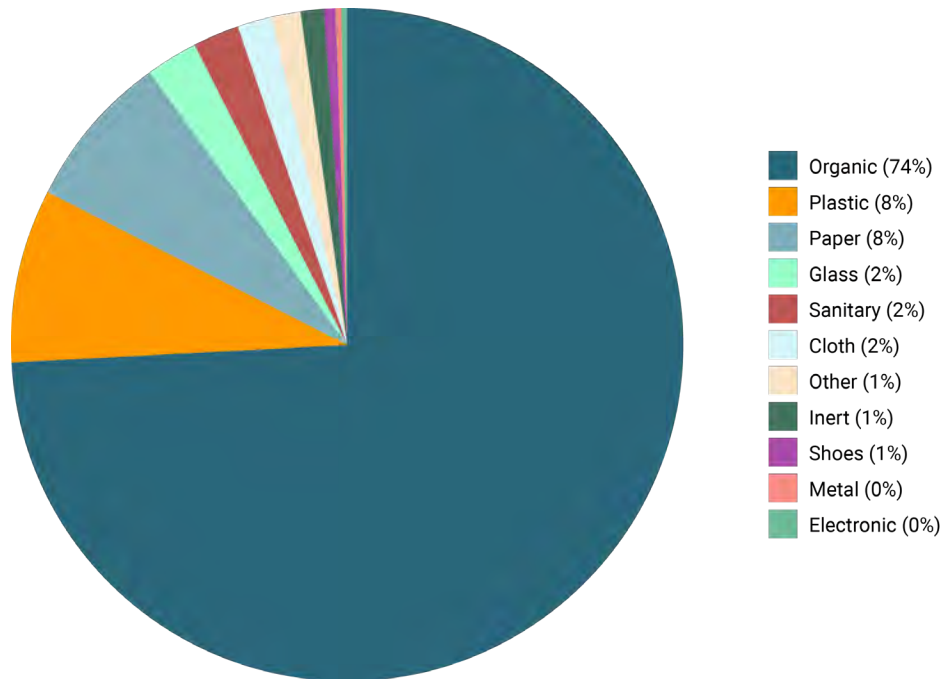
The SWM Strategic Plan sets ambitious goals to maximize collection and waste management in Pune by 2025, which includes reaching 100% coverage of DTDC and 100% of source segregation (PMC 2017). While it is clear that there are still barriers related to public perception, behavior change, and existing infrastructure both old and new which need to be addressed for sustainable long-term change, the desire for change from the city appears to be in place.

End of Cycle

Similar to other countries in the region, the majority (74%) of the municipal solid waste that is generated in Pune is organic, followed by plastic and paper which both represent 8% of the waste stream respectively (Sohkhlet and Nagargoje, 2020). A large amount of organic material and general diversity of the waste stream in Pune has led to a wide range of processing plants being developed. As of 2021, the city of Pune has 7 transfer stations and 50 processing plants that process over 90% of MSW. That includes 19 wet waste processing plants and 13 dry waste processing plants — encompassing 10 bio-methanization plants, one bio-CNG plant, and 2 mechanical composting plants — as well as one hazardous waste processing plant, one plastic to fuel processing plant, and several MRFs (PMC 2021). With the high proportion of organic waste in Pune, in-situ composting is critical and currently mandated by the local government. In 2016, there were reportedly 2,000 bulk waste generators creating more than 100kg of waste per day

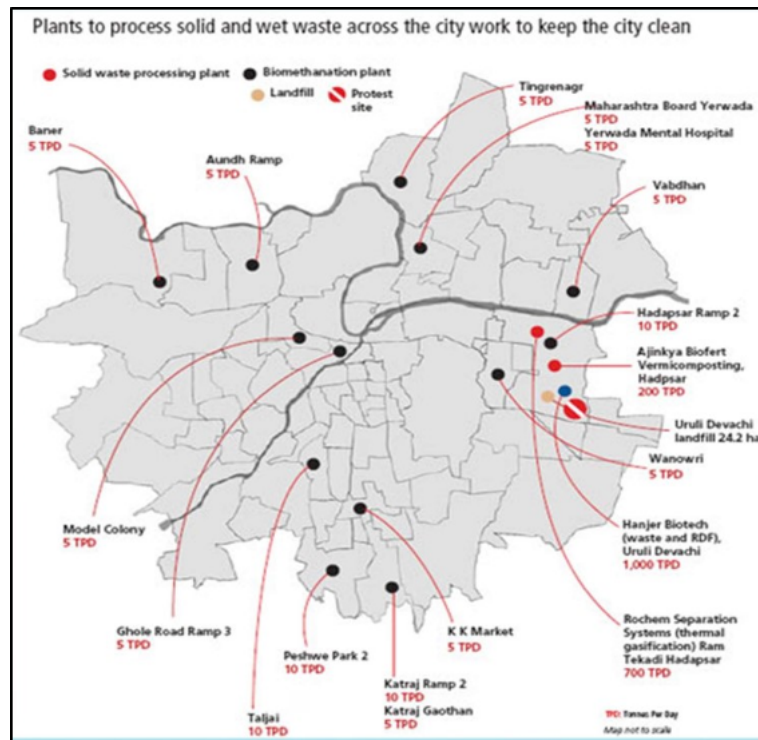
that were mandated to manage their wet waste at source (SWM 2016). However, it was mentioned in the interview process that the implementation and enforcement of the mandate has been slow and insufficient, and only 40% of the bulk waste generators are following the requirements.

Figure 16: SWM Composition in Pune



(from Sohklet and Nagargoje, 2020)

Despite the many and diverse types of processing plants available to support SWM in Pune, many have yet to operate at their full capacity. It was estimated in 2017 that all of the processing plants in Pune were collectively operating at around 50% of their installed capacity. Two of the largest plants in particular—Rochem and Noble Exchange Bio-methanation—were only processing at 36% and 16% of their installed capacity respectively in 2017 (PMC 2017). However, since the release of the Plan in 2017, PMC has installed several decentralized dry waste processing plants, many of which are operating at near capacity. Since 2017, the Rochem plant has been shut down and the Noble Exchange plant has surpassed 50% capacity (PMC 2021). Local government representatives feel that the city’s encouragement of local technology providers to develop equipment tailored to meet the needs of waste processing in Pune in recent years has led to the success in increasing waste processing amounts and reducing the amount of waste leakage and waste destined for landfill.

Figure 17: Locations of processing plants in Pune

(From PMC SWM Strategic Plan 2017-2025)

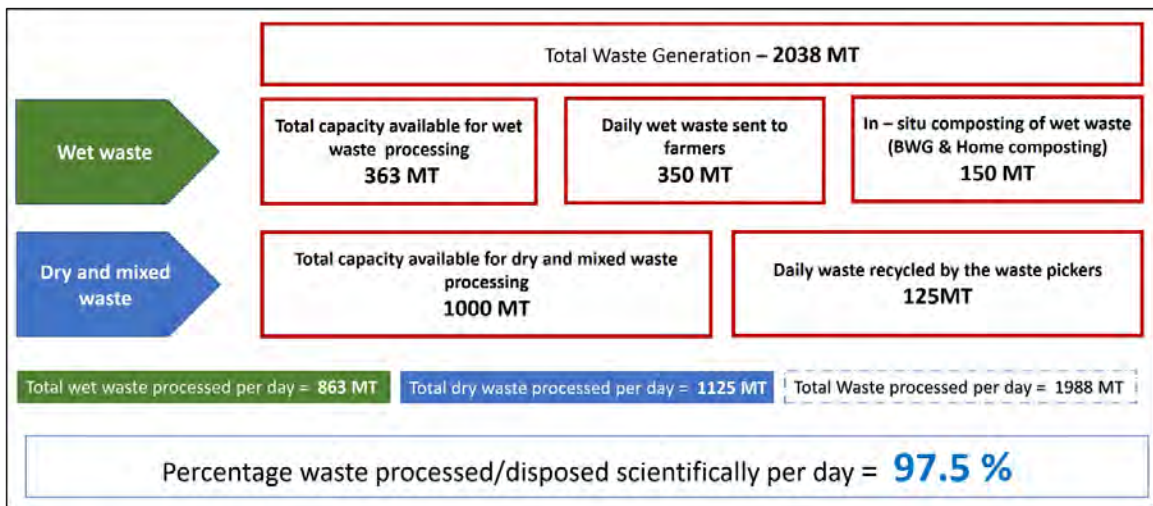
Despite the recent enhancements and improvements to the system, waste processing and clarity surrounding the various new options and infrastructure was still cited by many in the stakeholder interview process as a key challenge for SWM in Pune.

“Processing of the waste is a huge challenge. People and workers are not yet familiar with the new technological support and working available for it. They find it as a risk-taking option... In that sense, the clear understanding of which technology to choose in SWMs is not still there. There is a wide variety of products available and even the rates vary accordingly”

— Business Consultant

The main landfill that services Pune—the Uruli Devachi landfill—is being filled at a rate faster than planned and is running out of capacity. As of 2020, around 35% of the 43-hectare landfill had reached full capacity and been permanently sealed (Sohkhlet and Nagargoje, 2020). The SWM Strategic Plan also cites several times that the city has concerns over available land for proper waste management and associated infrastructure to support the city’s growing needs, particularly to handle the wet waste. The city has made it a priority in its strategy to acquire more land for installing new waste processing plants as well as optimizing the operational capacity of existing infrastructure (PMC 2017). The issue of processing space was also raised often in the stakeholder interviews as a challenge for proper waste management in Pune, particularly related to recycling. Since 2017, PMC has been able to decrease the amount of the SWM stream that is diverted to the landfill to 10%, and it hopes to decrease that to less than 5% by 2022, which is the estimated time at which it will reach capacity (PMC 2021).

Figure 18: Solid Waste Quantities in Pune as of 2021



from Pune Office of Resilience, 2021.

In terms of recycling, there is a formal as well as an informal structure in Pune. The collection fee is included in the standard fee that residents pay to PMC for DTDC. Many explained that the volatility in both the quality of the product and the price available for the product hampered informal recycling, particularly smaller-scale operations.

“If you look at recyclables, recyclers mostly work on a very small scale. You will rarely see well-established recyclables working in terms of paid bottles. Paid [PET] bottle recyclers work in huge quantities. More than a thousand tons per month. If you look at small-scale recyclers, their capacity is about 40 tons. Even if those people have the knowledge, they do not have the capacity to work at a certain level!”

— Business Owner

“If I am a recycler, I want to provide a certain quality material to the next customer. There is always uncertainty as to whether it will be fulfilled or not.”

— Business Owner

“People say that they make fuel from plastic and then they want to make so much income from it. So for high income, you should deliver high quality of plastic – they select only high-quality plastic only. And the industry is such that you have no control over the quality of the raw material!”

— Government Worker

“It’s not a fixed or regular income; it depends on what these families are ordering or consuming. Low grade single use plastic material does not have recycle value. Plastic

spoons, containers do get some recycle value. There is a better rate for things like putha (cardboard), white (white paper) etc. But most of the material does not get good value."

— SWaCH Waste Picker

"We should get some fixed price for recycling material. Rates for different materials keep on changing. If there is some fixed rate then we also know what type of waste we should retrieve more."

— SWaCH Waste Picker

In contrast, the government operations are larger in scale but require licenses and permits that take a long time to process and the benefits often don't outweigh the cost of operating independently of the government. Many business owners expressed a sense of "fear" when it comes to government waste management and recycling operations. The informal and formal operations seem to be viewed as in conflict or at odds with one another, and the advantage to participating in government structures for waste collection and management is largely unclear to those in the waste sector.

"There are a lot of recycling centers in this lane, but no recognized recycling centers. That means no one has a permit. Out of the 15-20 recycling shops in Pune, only 2 shops have licenses. The government thinks of this work as stealing, whether it is waste pickers or scrap shop owners. Due to this, you will see the recycling plants are located outside of the city... Those who do not have a license are not identified at all... Until you do not give these shop owners an authorized government license, one cannot understand [the waste management] issue."

— Waste Collector

"In the recycling stage, people are afraid of the government. Even for those who collect waste in the stage of sourcing, they always look at the government with awe. They never think that the government is there to help them."

— Business Owner

"These workers received, for example, 50 Rupees, but SWaCH cut 5% of their payment and the people realized this and dissociated from the organization and started their individual work... The reason that the SWaCH organization broke off is because their top leader did not let the money reach these workers and I have seen this with my very own eyes. It is alright if they take an additional 50 Rupees to the 50 Rupees that they already take. They can charge it for their office or for any other work they need but the remaining money must be handed down to the workers."

— Waste Collector

A notable project that demonstrates innovation in end-of-life processing in India is Protoprint. This four-year project of Protoprint, SWaCH, and the European Union was started in India in 2020 with the aim of increasing the value of PP and HDPE waste and in turn improving the livelihoods of waste pickers. Durable plastics such as PP and HDPE are purchased from waste pickers at a higher price and ultimately used for higher-value intermediate products such as 3D printing filament. The project plans to incorporate over 1,000 waste pickers, create over 60 jobs, and increase productivity and values throughout the plastic supply chain. At the end of the four-year project, the intent is to have the processing units for the higher-value intermediate plastic products be wholly owned and operated by waste pickers (SWITCH-Asia 2021). With the booming IT, manufacturing, and engineering industries in Pune, there could be an opportunity to scale mechanisms such as this to maximize collection and incorporate more waste plastics into high-value products.

The city of Pune has made strides in recent years to address solid waste management in a variety of ways beyond processing infrastructure. PMC partnered with Janwani, Cummins India, SWaCH, waste pickers, and other stakeholders to establish a [Zero Garbage](#) model, starting with a pilot project in the Katraj ward. The main objective of the project is described on their website:

“The primary objective is the proper segregation of organic and inorganic waste. Organic material is used in the bio-gas plant which completely eliminates transportation cost to the landfill. Inorganic material, such as plastics and glass, are sold as scrap. The objective of Zero Garbage Project is to process all waste at the ward level itself, thereby reducing transportation and labour costs and subsequently eliminating the need for landfills.”

The implementation involved different components of waste collection and processing, including a new biogas plant, as well as public outreach campaigns and the removal of public bins to encourage DTDC. From PMC reporting and stakeholder interviews, it seems as though the implementation was met with mixed feelings from the public, and there were barriers particularly around the public understanding of waste segregation. It will be beneficial for the city to follow the monitoring that is planned for this pilot and determine whether a similar model would be viable in other parts of the city.

Other notable developments or plans from PMC include the preparation of a Plastic Waste Management Plan for Pune that aligns with the Plastic Waste Management Rules from 2016 that include EPR. The Corporation has also said that it plans to create 200 material recovery centers with the goal of properly processing (either through reuse or recycling) 170 to 180 MT of the waste that is collected per day. They also reportedly intend to purchase PET bottle crushing machines at 20 locations with high pedestrian footfalls and to have a toll-free number available for residents to get information on where and how they can recycle their waste ([PMC website 2021](#)).

Within the SWM Strategic Plan that was developed by PMC in 2017, several critical gaps were identified related to waste processing that, according to stakeholders, still remain a challenge today (PMC 2017):

- The extent of the recyclable waste collection system is limited
- The provision of decentralized recycling and reliable wet waste treatment facilities is limited
- Utilization of treatment infrastructure is very low
- Over-dependence on landfills leading to environmental and social issues
- Availability of land to expand or replace the landfill, which is expected to reach capacity in 2022

The Plan also notes several policies and community-related barriers that would further optimize the existing and planned future waste management infrastructure, such as the fact that no outreach program promotes domestic or commercial waste reduction. The other issue raised is that there are challenges with cost recovery for waste services provided (PMC 2017). While the user-free based system, is reported to save nearly 113 Cr per year, there are large costs associated with the collection of waste with trucks and equipment, etc. Waste pickers are paid through user fees and from the sale of recyclables, which does off-set collection costs, but this is not enough for long-term sustainability. The extensive costs of waste collection and management could be addressed with extended producer responsibility schemes providing resources as well.

In addition to the Strategic Plan, the Pune Resilience Strategy has a dedicated goal under the Environment Pillar to promote the circular economy of Pune through waste management. The goal outlines three key actions to be taken by the city (Resilient Pune, 2019):

1. Strengthen the capacity of PMC and the circular economy ecosystem towards 100% in situ processing of organic wastes, recovery of recyclables, and liquid waste management
2. Support formalization of scrap recycling economy and improve sanitation worker safety and livelihoods
3. Promote public behavior change for sustaining the circular economy

Within the Resilience Strategy there are several projects that have been outlined within each of those activities, with responsible entities, specific objectives, metrics of success, and resilience factors for each. These include establishing an EPR desk at PMC to specifically address hard-to-recycle materials, creating a "Scrap Map" for the city of Pune to visualize the movement and value of waste and identify opportunities for improvement, developing a citizen's participatory governance committee at the ward-level for circular economy and solid waste management, and several others (Resilient Pune, 2019). This sets a strong course for Pune in moving towards circular materials management in the coming years and the progress and success of the strategy should be regularly monitored.

While there are significant challenges within Pune related to processing capacity and infrastructure in particular, but it is promising that plans with specific targets are in place to address these challenges within the next five years. Concrete steps can be made to increase the efficiency of the waste management stream in Pune, and while public perceptions are mixed it would seem that there is both government and corporate support for such initiatives.

Leakage

In total, 8,378 litter items were recorded across 27 100m² transects in nine different square kilometer areas sampled between October 2020 and February 2021. Litter transect locations were selected using a stratified random sampling method, in which transects were randomly selected in nine square kilometers which were distributed across three groups of population count (upper, middle, lower) based on LandScan ambient population data. Litter items were recorded using the open-source [Marine Debris Tracker](#) (MDT) app. A full list of items available in the app and their associated material categories can be found in the Appendix.

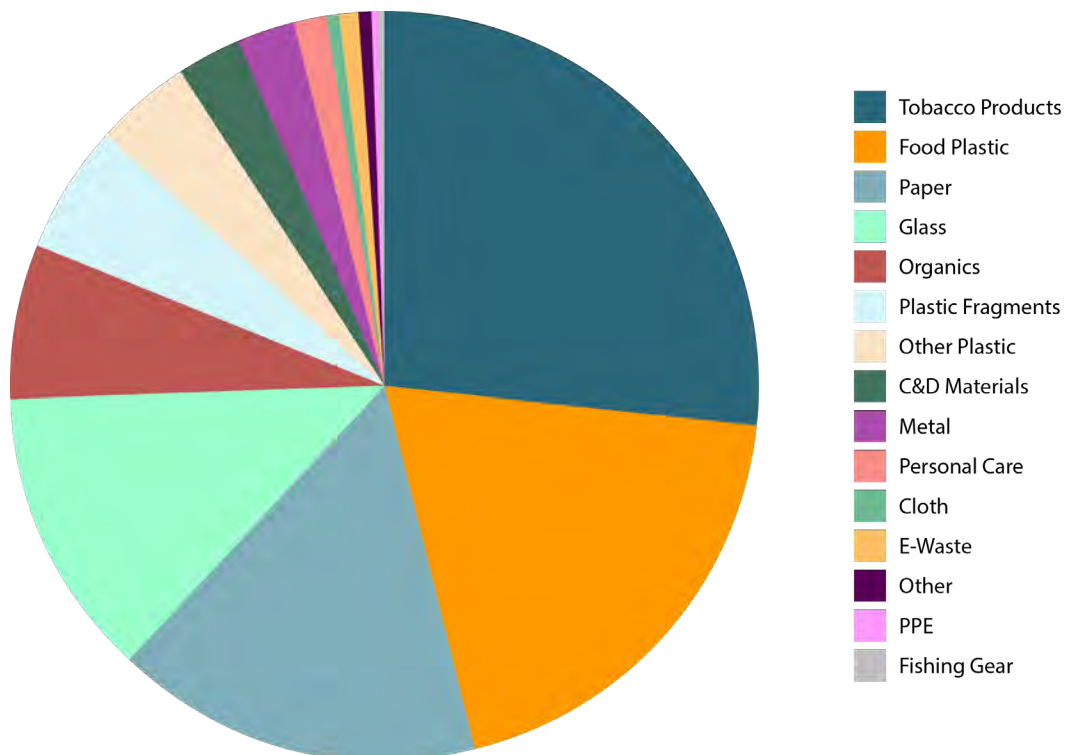
Figure 19: Litter tracking in Pune



(Photo Credit: CEE)

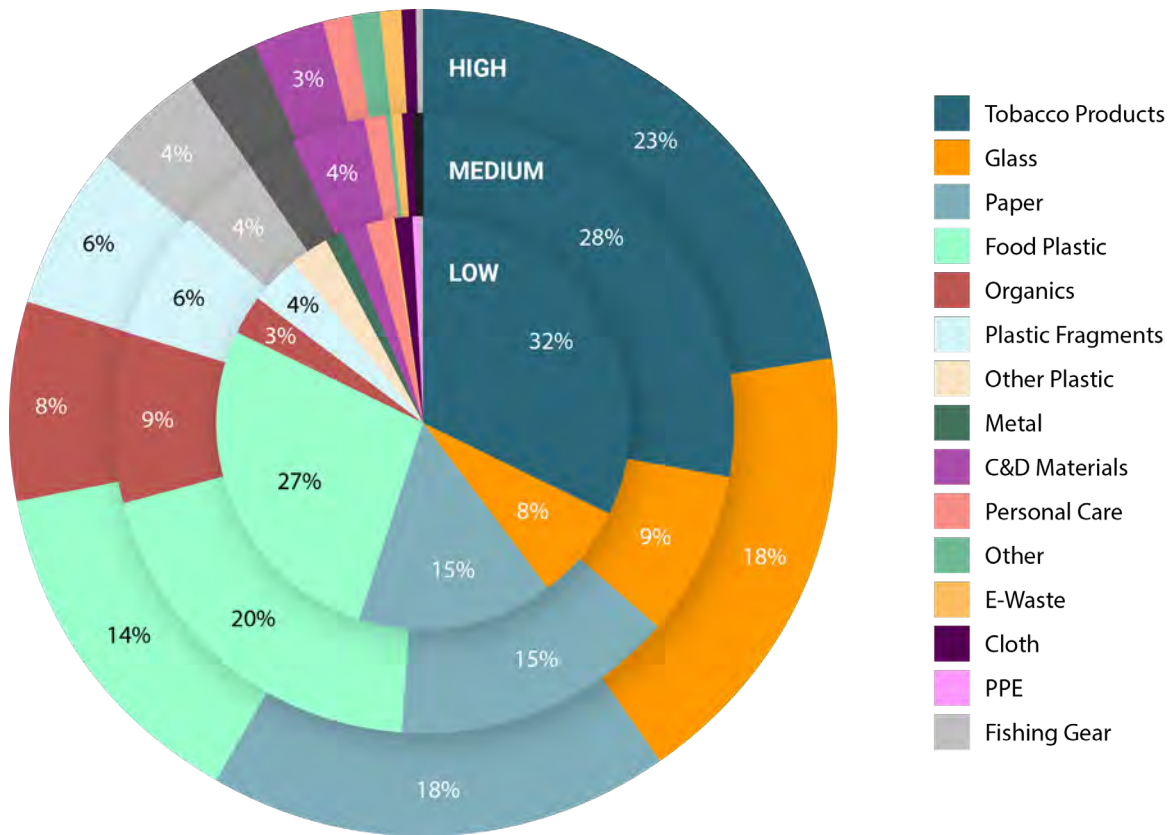
Across all 27 transects, the largest percentage by category of litter items (27%) was tobacco products. Food plastic, paper, and glass items comprised between 12% and 19% of all of the litter items. Organics, plastic fragments, other plastic, C&D materials, and metal items comprised between 2% and 7% of all of the litter items, while the remaining material categories—personal care, cloth, e-waste, other, PPE, and fishing gear—represented less than 2% of all litter items respectively (Figure 19). The total percentage of common plastic items (the sum of food plastic, plastic fragments, other plastic, PPE, and personal care items) found was around 30% of the total items, which was lower than the amount observed in other cities from Urban Ocean Cohort 1

Figure 20: Material Breakdown of Litter Items in Pune



When examining the litter characterization based on the population count — which is a measure of ambient population, encompassing the quantity of people that pass through a given area in a day as opposed to residents in a given area — we see some distinctions can be seen between the three groups (Figure 17). In terms of material type, tobacco products were the main material type among litter items in all three population count areas, ranging between 23% and 32% of all litter items. In the upper population count area (36,568 – 77,275 persons/sq km), this was closely followed by glass and paper products. In contrast, in the middle (13,910 – 36,568 persons/sq km) and lower population count area (740 – 13,910 persons/sq km), the second most abundant litter material was food plastic, followed by paper products in a lower percentage than seen in the upper population count areas. Organic items represented nearly three times more of the total litter items in the upper and middle population count areas as compared to the lower population count areas (around 9% and 3% respectively). Plastic fragments, other plastic, metal, and C&D materials were all seen in higher proportions in the upper and middle population count areas than in the lower population count areas.

Figure 21: Proportion of most common material types among litter in lower (inner), middle (middle), and upper (outer) population count areas in Pune



We also see distinct patterns between population count areas in terms of individual litter items (Table 5). Tobacco sachets represented the most or second most abundant litter item in all three of the population count areas. Paper litter was also seen among the top five items in all three of the population count areas. Multiple types of tobacco-related items, including sachets, cigarettes, and another tobacco packaging, were among the most common items in all areas. Ceramic or glass fragments and organic waste were uniquely found among top items in the upper and mid-

dle population count areas. Glass items were typically alcohol bottles or fragments of glass bottles of unidentifiable origin, and organic waste items were most commonly food waste or dog feces. Plastic food wrappers were uniquely found among top items in the middle and lower population count areas.

Table 5: Litter Density and Top Litter Items from All Transects in Pune

| Population Tertile | Top 5 Litter Items | Litter Density (count/m ²) |
|---|--|--|
| Upper (36,568 – 77,275 persons/sq km) | 1) Glass or Ceramic Fragments, 2) Tobacco Sachets, 3) Paper, 4) Cigarettes, 5) Other Organic Waste | 4.22 |
| Middle (13,910 – 36,568 persons/sq km) | 1) Tobacco Sachets, 2) Paper, 3) Plastic Food Wrapper, 4) Glass or Ceramic Fragments, 5) Other Organic Waste | 2.31 |
| Lower (740 – 13,910 persons/sq km) | 1) Tobacco Sachets, 2) Plastic Food Wrapper, 3) Paper, 4) Other Paper, 5) Other Tobacco Packaging | 3.11 |

PMC and SWaCH document known areas of chronic litter spots and legacy waste spots throughout the city in their monthly reporting. As of June 2021, there were a documented 299 chronic spots and 33 legacy waste spots in Pune (SWaCH monthly report, June 2021).

Litter densities across other developing countries in South Asia typically range from 0.5 items/m² to 15 items/m², with an average of around 4-5 items/m² (n = 40). The litter in Pune is below the average values of those observed in South Asia for the middle and lower population count areas and the near average for the upper population count areas. Litter density in Pune is also higher than that found in a small island nation (1.8 items/m²) for all population count areas (Youngblood et al., In Preparation).

Similar data was found from the Plastic Waste Audit that was conducted by SWaCH in Pune in October 2020. The audit revealed that multi-layer plastics – including small sachets or other low-value materials and films – were the most common plastic waste item from households, representing 44% of all plastic sampled (by count), and 76% of all plastic waste was food packaging. The second most common plastic waste item was single-layered LDPE at 27% of all plastic waste, which largely comprised of milk packets, followed by PET at 14%, PP at 10%, HDPE at 3% and PA at 1%. In terms of plastic material type, the audit found that the top plastic producer for multi-layer plastic was Nestle, for LDPE and PS was Chitale Foods, for PET was The Coca-Cola Company, for PP was largely unmarked restaurant take-away containers or food packaging, and for HDPE was Reckitt Benckiser (SWaCH 2020, press release).

While LDPE milk packets comprised a significant amount of the household plastic waste stream based on the SWaCH brand audit in Pune, the LIP noted that they may not have shown up as prominently in the litter transects because households often either have milk delivered to their home or bring purchased milk directly back home after purchasing. These are often disposed of in household dry waste bins, and some households reportedly store their washed and empty milk packets to sell to the raddiwala as part of the informal waste sector.

Opportunities

We recommend exploring the following opportunities to expand and enhance circularity in Pune based on the findings of this report. These opportunities are categorized based on the seven spokes of the CAP model and are roughly listed based on the level of potential impact to reduce plastic waste in Pune within each spoke. The purpose of the forthcoming Opportunity Assessment Workshop in Pune as part of Urban Ocean is for the city to further prioritize these opportunities based on impact, feasibility, and cost. It is important to note that the opportunities listed below are individualized based on the findings, but solutions cannot happen in a vacuum and are most impactful when strategically combined within a holistic system framework.

INPUT

- Extended Producer Responsibility (EPR) and packaging design changes – major opportunities to implement and enforce EPR domestically among top brands that have parent companies and manufacturers based in India, especially for problematic multi-layer film items from products like candy and chips

COMMUNITY

- Reinstate community outreach directly between PMC and the citizens of Pune, and ideally a third-party conduit that can communicate key messages on source segregation, user fees, collection protocols, recyclable material, and other important factors to maximize collection and processing of waste.
- Explore ways to improve communication and transparency with the community as well as with local businesses and waste workers – concentrated to build trust, allow residents to see positive action and follow-through (enforcement), and build incentives for inclusion in formalized waste systems, etc.
- There is a specific need to run an awareness campaign for citizens on the impact of littering due to tobacco packaging and cigarettes, as awareness particularly around the impact of those items is limited. Such a campaign could focus on multi-layered plastic food package littering as well.
- With a relatively young population (62% below the age of 30), there are opportunities to engage younger generations in Pune around solutions and innovation.

PRODUCT DESIGN

- Multilayer plastic packaging is most common among top convenience items, and companies and manufacturers for brands of those top products were largely located domestically. There could be opportunities for material innovation and EPR to either redesign that packaging or create value in recapturing it after it is used.
- Expand upon the use of biodegradable (paper) products in to-go items, see if there are ways to bring in other restaurants and vendors that are still using plastic, particularly casual restaurants, and Snack Centers.

USE

- Explore returning to the historic practices around refillable and reusable items, especially for top grocery and convenience items – perhaps through a targeted outreach campaign, incentives, etc.
- Possibility to develop incentives for businesses to use alternatives or reusables – currently, single-use disposable plastic items are most available, easiest, and cost-effective, and businesses don't feel like they have government support to make changes even if they want to
- Investigate the businesses that are taking initiative and action in this area – they could be used as case studies or models that could be scaled, shared on social media, awarded by the government, provided support from other local businesses, etc.

COLLECTION

- Efficiency, duplicity, and bottlenecks should be closely examined and mitigated in the waste management system of Pune. Improved coordination and communication is needed between the various decentralized systems that operate simultaneously or in similar locations in the city, particularly for primary and secondary collection.
- Re-evaluate the processes surrounding DTDC to optimize collection (i.e., timing or methods may need to be changed for neighborhoods where people are currently not home when collection occurs, collection may need to occur more frequently or in a staggered manner, etc.).
- Explore options to distribute secondary collection and transport vehicles more efficiently, improve the quality and quantity of vehicles available for collection and transport, and reduce wait times at transfer stations (i.e., installing temporary storage bins at ramps).
- It's clear that the debate around the formalization of the waste picker community in Pune is a contentious one – it would be beneficial for the city to explore that option and have an open dialogue with stakeholders about incentives that could be developed, general pros and cons, as well as other measures that could be taken to improve the safety and livelihoods of the informal waste sector and level of service. Ideally the partnership between PMC and SWaCH should be renewed in 2021, with improvements made to the agreement where needed.
- Increase public education efforts (and maybe incentive schemes, if feasible) around source segregation. Enforcement of existing mandates related to source segregation and in-situ composting should be prioritized.
- Sorting sheds and temporary storage facilities for recyclables need to be made available to SWaCH workers to sort and package recyclables for export. These should be well organized, safe places to work in that are distributed around the city, because they were often cited as an “occupational hazard.”
- Use of ICT to set up a dashboard/app-based platform for tracing and monitoring of waste flow, especially, recyclables are required. This will also help in creating a marketplace to bring all market players on a common platform to increase the business prospect of recycling. There are already few players, start-ups working in this space (digital platforms, waste monitoring, marketplace, etc.) in India and Maharashtra state.
- Managing organic waste is also a critical priority for the city. The waste management department may want to explore in-situ wet waste management solutions that can be used to upgrade its 25 decentralized biogas plants processing organic waste. PMC has already been in discussions with local organizations to explore options.
- PMC collects and tracks data through mobile app technology (90% of generated waste), e.g., how much dry and wet waste comes through every transfer station, processing plant, from which ward, etc.) – Pune could be one model for this type of data collection. This information would also be useful for supporting and tracking EPR.

- Addressing plastic waste in an isolated manner may not be feasible in the local context, hence it may be useful to focus on organic waste, e-waste (also contains a certain quantity of plastics,) and plastic waste together. This will also help in making the business case and creating a larger impact.

END OF CYCLE

- Recommend an assessment of existing and planned processing infrastructure in Pune, as well as ongoing assessments for monitoring – ideally, existing plants would be able to reach operational capacity (i.e. solving upstream challenges related to segregation, collection, transport, technical education of workers, staff and resources, etc.) before additional plants are developed, as the infrastructure should match the needs of the city
- Monitor the progress of the Zero Garbage pilot project in Katraj and determine whether a similar model could be feasible in other parts of Pune and what might be needed to make it successful
- Strengthening existing or setting up new Material recovery facilities on Public-Private Partnership (PPP) mode or through private player intervention is required.
- The city may want to develop a community-led model for recyclers (similar to its collection model), which will formalize the informal sector MSME recyclers in the city.
- The city is currently lacking large-scale specialized treatment facilities for items such as E-waste, C&D waste, and garden waste. PMC has reported that the city intends to bring such facilities to the city in a public-private partnership (PPP) basis.

LEAKAGE

- Tobacco products were the most common type of litter item found across the whole city as well as for each population count area, with tobacco sachets being among the top items in each area – it's clear that these items tend to escape the formal and informal waste streams in the city, so it may be worth exploring ways to reduce littering, as well as optimize collection and processing of that waste
- While Tobacco companies and manufacturers were on average located the farthest from Pune compared to those of other top product types, it is clear that those items pose the biggest challenge when it comes to litter and waste leakage – it would be worth exploring EPR measures that could be implemented (or public health messaging), starting with brands located domestically

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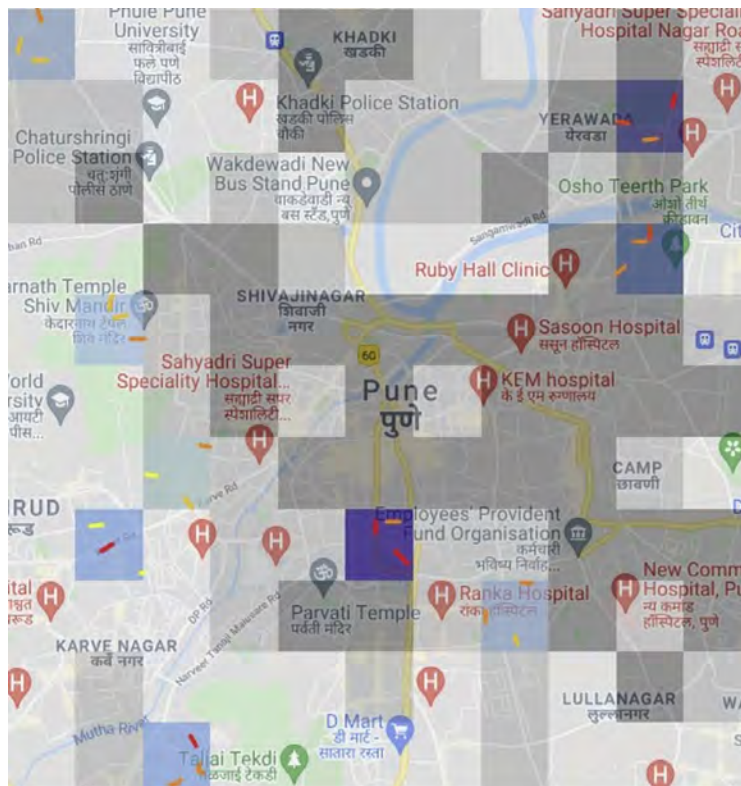
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Appendix

Figure 22: Litter Densities and Population Count from CAP Transects in Pune



Litter Denisty for Transect (items/m)

- < 1
- 1 – 2.5
- 2.5 – 3.5
- 3.5 – 4.5
- > 4.5

Average Litter Density in Sq Km (items/sq m)

- 2
- 2 – 3
- 3 – 4
- 4 – 5
- > 5

- Upper population count (36,568 – 77,275 persons/sq km)
- Mid population count (13,910 – 36,568 persons/sq km)
- Lower population count (740 – 13,910 persons/sq. km)

Table 6: Full List of MDT Litter Items and Associated Material Categories

| Material | Items |
|------------------------|--|
| C&D Materials | Aggregate & Brick Bolts, Nails, and Screws Building Materials Lumber Other C&D |
| Cloth | Clothing Fabric Pieces Other Cloth |
| E-Waste | Batteries E-Waste Fragments Other E-Waste |
| Fishing Gear | Buoys and Floats Fishing Line Other Fishing Gear Plastic Net or Net Pieces Plastic Rope |
| Glass | Glass Bottle Glass or Ceramic Fragments Other Glass |
| Metal | Aluminum Foil Aluminum or Tin Cans Metal Bottle Caps or Tabs Metal Fragments Other Metal |
| Organic Waste | Food Waste Other Organic Waste |
| Other | Other Popsicle Stick |
| Other Plastic Products | Bulk Bags Flip Flops Other Plastic Plastic String, Tape, or Packing Straps Rubber Bands Tires |

| Material | Items |
|------------------------|---|
| Paper | Coated Paperboard Corrugated Cardboard Multi-material Paper Box Noncoated Paper Food Wrapper Other Paper Paper Receipts |
| Personal Care Products | Blister Pack Cotton Buds Other Personal Care Product Personal Care Product Sachet Shampoo or Other HDPE Container Toothbrushes Toothpaste or Other Product Tube |
| Plastic Food Products | Foam or Plastic Cups or Lids Other Food-Related Plastic Other Plastic Bag Plastic Bottle Plastic Bottle Cap Plastic Food Wrapper Plastic Grocery Bag Plastic Utensils Straws Street Food Bowl Styrofoam Container |
| Plastic Fragments | Film Fragments Foam Fragments Hard Plastic Fragments Other Fragments |
| PPE | Associated PPE packaging Disinfectant Wipes Disposable Gloves Face mask packaging Face Masks Face Shield Hair nets Hospital shoe covers Other PPE |

| Material | Items |
|------------------|---|
| Tobacco Products | Cigarette Packaging Cigarettes Other Tobacco Product Tobacco Sachets |

Table 7: Locations of Parent Companies and Manufacturers of Top Convenience Items in Pune

| Item Type | Manufacturer | Manufacturing Location | Parent Company | Parent Company Location |
|-----------|-------------------------------------|------------------------|---------------------------|-------------------------|
| Chips | Aaiji Food Processors | Pune, India | Aaiji Food Processors | Pune, India |
| Candy | Amul | Gujrat, India | Amul | Gujrat, India |
| Beverages | Amul | Gandhinagar, India | Amul Fed Dairy | Gandhinagar, India |
| Candy | Dharpal Prem Chand LDT | Assam, India | Baba Group | New Delhi, India |
| Chips | Balaji | Gujrat, India | Balaji | Gujrat, India |
| Chips | Budhani Brothers | Pune, India | Budhani Brothers | Pune, India |
| Candy | Cadbury | Mumbai, India | Cadbury | Mumbai, India |
| Chips | Ghodawat Foods Internatinal PVT LTD | Kolhapur, India | Cavin Kare (p) LTD | Chennai, India |
| Beverages | Cavin Kare (p) LTD | Tamil Nadu, India | Cavin Kare (p) LTD | Chennai, India |
| Beverages | Chitle Agro | Maharashtra, India | Chitale Agro | Sangli, India |
| Beverages | Danbur India | Uttarakhand, India | Dabur India | New Delhi, India |
| Beverages | Dairy Reach Food | Kolhapur, India | Dairy Reach Food | Kolhapur, India |
| Tobacco | Damodar Jagannath Malpani | Sangamner, India | Damodar Jagannath Malpani | Sangamner, India |

| Item Type | Manufacturer | Manufacturing Location | Parent Company | Parent Company Location |
|-----------|-------------------------------------|------------------------|------------------------------------|-------------------------|
| Chips | DFM Foods LMT | Greater Noida, India | DFM Foods LMT | New Delhi, India |
| Candy | Kohinur Biscuit Paroduct | Uttar Pradesh, India | DS Confectionery Product LMT | New Delhi, India |
| Tobacco | VSPM Product / Malpani | Sangamner, India | Fast Pack Bankers | Sangamner, India |
| Tobacco | International Tobacco | Mumbai, India | Godreg Phillips Ltd | Mumbai, India |
| Beverages | Govind Milk & Milk Products PVT LTD | Maharashtra, India | Govind Milk & Milk Product PVT LTD | Maharashtra, India |
| Chips | Greendoot, Health Food | Bhagwanpoor, India | Greendoot | Haryana, India |
| Chips | Haldiram Food Inc pvt ltd | Bhandara, India | Haldiram Food Inc pvt ltd | Bhandara, India |
| Tobacco | Harsh Infenity Flower pvt ltd | Haryana, India | Harshpan Products PVT LTD | Haryana, India |
| Candy | The Himalaya Dpug Company | Karnataka, India | Himalaya | Madhya Pradesh, India |
| Beverages | Hindustan Coca Cala PVT LTD | Gujrat, India | Hindustan Coca Cala PVT LTD | New Delhi, India |
| Tobacco | Hongyunhonge Tobacco Group | China | Hongyunhonge Tobacco Group | China |
| Beverages | Huhatmaki Pvt Ltd, Silvasa | Haryana, India | Huhatmaki Pvt Ltd, Silvasa | Gurgaon, India |
| Candy | Inbisco India pvt ltd | Ahmedabad, India | Inbisco India PVT LTD | Hyderabad, India |
| Chips | Knchan Metals PVT LTD | Uttar Pradesh, India | ITC LTD | Bangalore, India |
| Chips | ITC Limited | Pune, India | ITC LTD | Bangalore, India |
| Tobacco | HDFC(P) LTD | Hyderabad, India | ITC LTD | Kolkata, India |
| Tobacco | ITC limited | Kolkata, India | ITC LTD | Kolkata, India |

| Item Type | Manufacturer | Manufacturing Location | Parent Company | Parent Company Location |
|-----------|----------------------------------|------------------------|------------------------------------|-------------------------|
| Beverages | Kutwal Foods Urja | Pune, India | Kutwal Foods Urja | Pune, India |
| Candy | Lotte India Corporation LTD | Nellikuppam, India | Lotte India Corporation LTD | Chennai, India |
| Candy | Bunty Food Product | Pune, India | Malpani Products, Ahmednagar, Pune | Ahmednagar, India |
| Candy | Mars International India PVT LTD | New Delhi, India | Mars International India PVT LTD | New Delhi, India |
| Tobacco | Evercast Industrial llp | Gujrat, India | Mauikchand Group | Pune, India |
| Tobacco | Dhariwal Industries PVT LTD | Bangalore, India | Mauikchand Group | Pune, India |
| Candy | Sam Ppe | Mumbai, India | Mondelez | Mumbai, India |
| Beverages | Nestle | Pune, India | Nestle | Gurgaon, India |
| Tobacco | Ppemghun | Madhya Pradesh, India | Palash Product | Madhya Pradesh, India |
| Candy | Parle | Mumbai, India | Parle | Rajasthan, India |
| Beverages | Parle Agro pvt ltd | Maharashtra, India | Parle Agro pvt ltd | Maharashtra India |
| Candy | Dhananjay Confectionaries | Mumbai, India | Parle Biscute Mumbai | Mumbai, India |
| Tobacco | RCMC Puckers | Mathura UP | PCMC Puckers | Uttar Pradesh, India |
| Chips | Pepsico | Pune, India | Pepsico | Gurgaon, India |
| Beverages | Varun Beverages LTD | Maharashtra, India | Pepsico | Gurgaon, India |
| Chips | Pepsico India Holdings Pvt Ltd | Gujrat, India | Pepsico India Holdings Pvt Ltd | Gurgaon, India |
| Candy | Perfetti Van Melle India Pvt Ltd | New Delhi, India | Perfetti Van Melle India Pvt Ltd | New Delhi, India |

| Item Type | Manufacturer | Manufacturing Location | Parent Company | Parent Company Location |
|-----------|-----------------------------------|------------------------|-------------------------------------|-------------------------|
| Tobacco | Phillip Morris Philippines | Philippines | Phillip Morris Philippines | Philippines |
| Beverages | Pinch Bog | Jalgaon, India | Pinch Bottling Co | Jalgaon, India |
| Candy | Prayagh Nutri Product | Hyderabad, India | Prayagh Nutri Product | Hyderabad, India |
| Candy | Kamala Consumer Care PVT LTD | Hyderabad, India | Ravi Foods PVT LTD | Hyderabad, India |
| Chips | Saffrino Food Prosecing Pvt Ltd | Pune, India | Saffrino Food Prosecing Pvt Ltd | Pune, India |
| Chips | Sanjay Ghodawat Group | Maharashtra, India | Sanjay Ghodawat Group | Maharashtra, India |
| Beverages | Schpeiber Dyanamix Daires PVT LTD | Mumbai, India | Schreiber Dyamix Daipes PVT LTD | Pune, India |
| Chips | Sheetal Cool Product LTD | Gujrat, India | Sheetal Cool Product LTD | Gujarat, India |
| Candy | Synergy Food Plastic | Thane, India | Synergy Food Plastic | Thane, India |
| Beverages | Hershey, India Pvt Ltd | Madhyapradesh, India | Tetra pack Media Pvt ltd Pune India | Pune, India |
| Beverages | United Breweries | Patana, India | United Breweries | Bangalore, India |
| Tobacco | VSPM Product | Karnataka, India | VSPM | Karnataka, India |
| Candy | Wrigley | New Delhi, India | Wrigley | New Delhi, India |

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