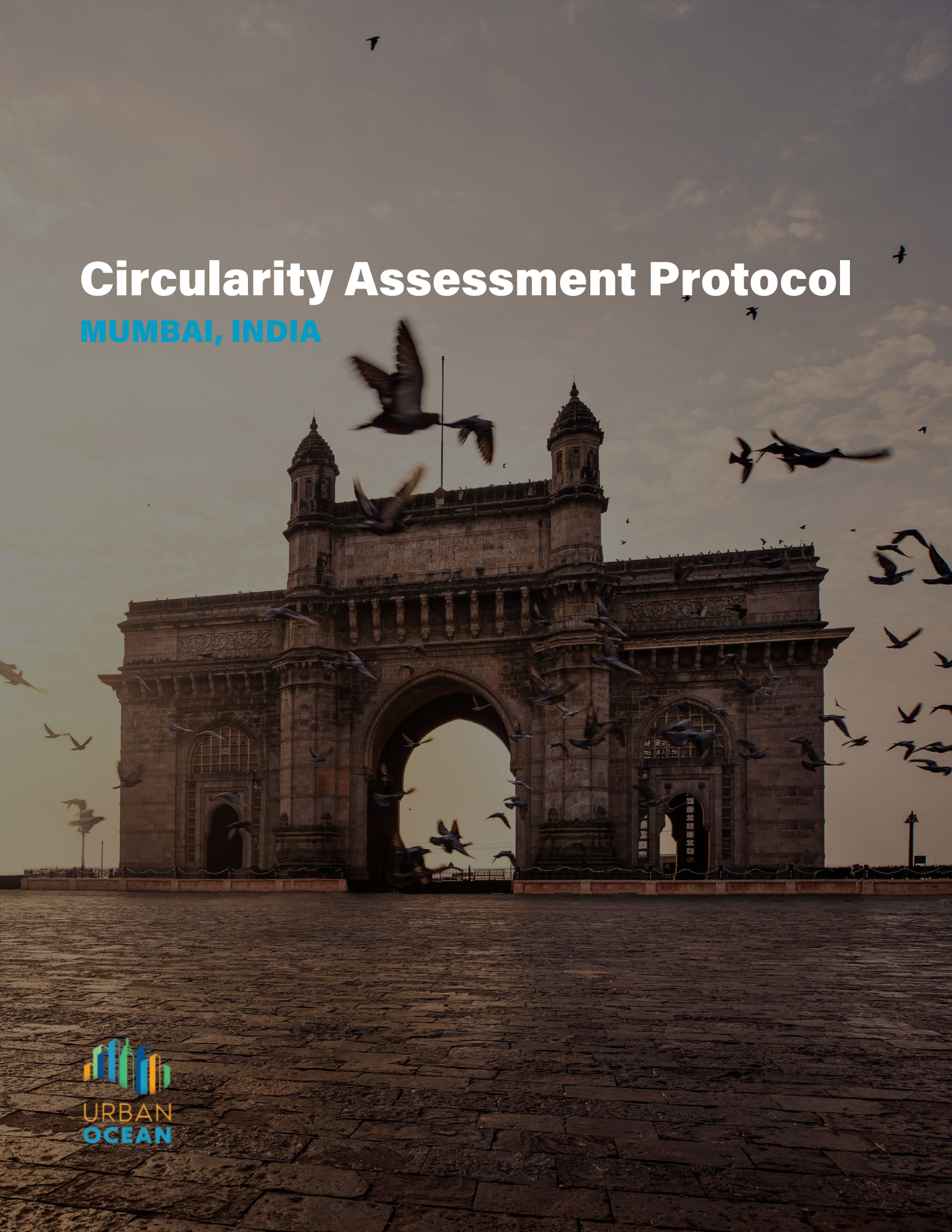
Circularity Assessment Protocol

MUMBAI, INDIA



URBAN OCEAN

Foreword

The Circularity Assessment Protocol (CAP) was born out of 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, 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 CAP, with additional data collected in partnership with CAP collaborators. Open data collection is an important part of the process, including leakage data. Once available, data trends across cities, countries and regions can also 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 the 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 following the launch of the first Urban Ocean cohort of cities. As a team, CIL 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 cities to drive scientifically informed decision making. Local implementation partners continued to work with the Urban Ocean team through stakeholder workshops and into the project identification I 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

Dr. Jenna Jambeck, Dr. Amy Brooks, Taylor Maddalene, Jenni Mathis, Kathryn Youngblood

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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www.circularityinformatics.org

Athens, GA, July 2024

New Materials Institute
UNIVERSITY OF GEORGIA

URBAN OCEAN

The Circulate Initiative

Ocean Conservancy

RESILIENT CITIES NETWORK

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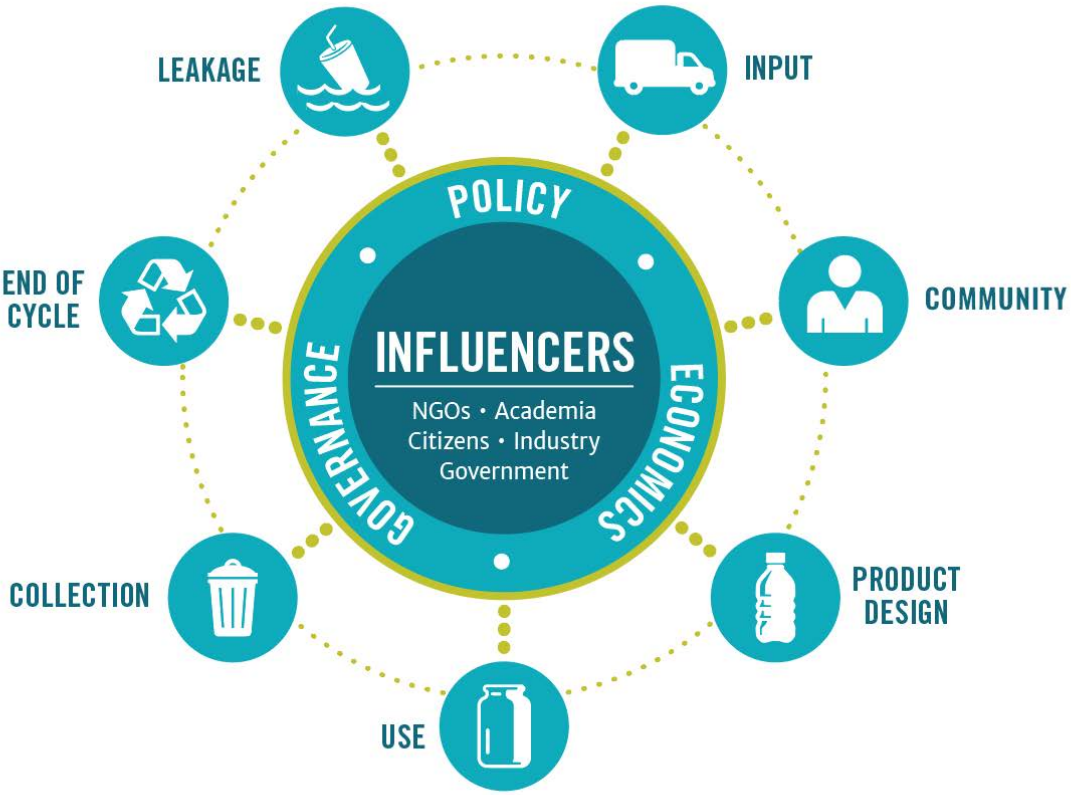
Executive Summary

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.



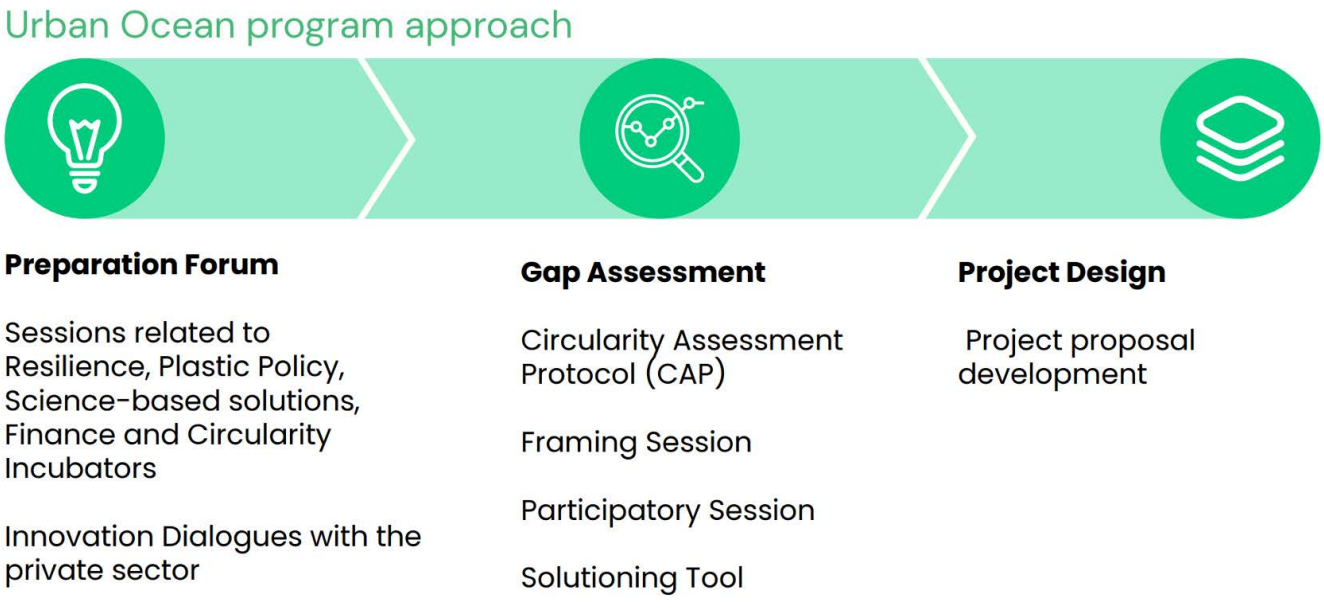
Between December 2022 and May 2023, a team from the Centre for Environment Education (CEE), with guidance and support from the Circularity Informatics Lab, conducted fieldwork in the city of Mumbai, India. The CAP was conducted with support from the city's local government, the Chief Resilience Officer (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 population activity. Key findings from each spoke are summarized in a subsequent table in this section.

Urban Ocean Program

Urban Ocean is a three-way partnership among The Circulate Initiative (TCI), Ocean Conservancy (OC), and Resilient Cities Network (RCN) 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.

Mumbai is one of 12 cities in Urban Ocean to-date. The CAP is critical to the next step which is the Opportunity Assessment, a phase of the Urban Ocean program 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 Mumbai will contribute to a series of workshops where stakeholders will discuss findings and develop a proposal(s) for interventions, 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 partners, they 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 1987, 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/trash-freeseas, 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. TCI achieves this by collaborating with key stakeholders across the sector, and by producing insights to support and accelerate investment and scale across the value chain. For more information, please visit: www.thecirculateinitiative.org

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. For more information, please visit: www.resilientcitiesnetwork.org

Key Findings and Opportunities

INPUT

Findings: Of all 161 fast moving consumer goods (FMCGs) sampled in Mumbai, 100% were manufactured domestically in India. Parent companies were located both domestically and internationally, though every category of FMCG product had at least one parent company located within India. Chewing tobacco products had parent companies that were on average located closest to Mumbai, and beverage projects were manufactured on average closest to Mumbai.

Opportunities

- Leverage Corporate Social Responsibility (CSR) measures for top consumer goods brands to increase and incentivize buy-back and repurposing programs, such as Bisleri's Bottles for Change program.
- With the high amount of domestic manufacturing locations, there may be impactful opportunities around extended producer responsibility (EPR), particularly for the most problematic types of items and packaging.

COMMUNITY

Findings: 15 stakeholders were interviewed across eight different sectors of society. Interviewees tended to express sadness when discussing the prevalence of waste in the environment, specifically waterways and sewage. Interviewees also tended to relate waste to larger issues related to income and workers' rights.

Opportunities

- Any changes to the waste management system must be thought of in relation to environmental and social inequalities, as the interviewees tended to view all of these issues as inherently intertwined.
- Interviewees felt that some opportunities for change lie in decentralized, grassroots movements and championed policies related to EPR and plastic bans.
- The city should enhance communication and engagement with the community around low and zero waste options, including information about dry waste collection centers, deposit schemes, and other innovations that are happening in the city.
- Education should be coupled with effective infrastructure so that behavior changes are as straightforward and seamless as possible.

PRODUCT DESIGN

Findings: 161 samples of top items were sampled from 18 grocery and convenience stores, and 42 to-go items were sampled from nine food vendors and restaurants. The majority of consumer items were packaged in multi-material packaging such as MLP and multilayer paper, which can prove difficult for sorting and waste management. While 50% of to-go items were made of plastic, each product category had some form of plastic alternative available. No recorded to-go items were labeled as biodegradable or oxo-degradable.

Opportunities

- Develop sustainable guidelines for events in Mumbai, and consider capturing lessons learned from other UO cities.
- The city may want to explore conversations around product design with domestic manufacturers, particularly those in close proximity to Mumbai, and for products packaged in material that has little value in recycling or is likely to end up in the environment.
- Expand upon the use of recyclable, home-compostable, and reusable products in to-go items, particularly for restaurants and vendors that are still using plastic.
- This CAP component, as well as others tangentially related, may provide data to support India's Plastic Pact efforts.

USE

Findings: 27 shops and food vendors were surveyed to determine the typical distribution of carrier bags to consumers. Most shops provided single-use plastic bags at no cost to the customers, which is in contrast to a current national ban. Some alternatives to single-use plastic bags were found (e.g., paper) at no additional cost to the consumer, though reusable bags were not found among stores and vendors surveyed. 20 single-use plastic alternative to-go items were found among vendors surveyed, most of which were paper.

Opportunities

- Enforcement of current product bans, particularly around single-use shopping bags, needs to be strengthened.
- Reuse infrastructure and reusable items were not readily found in Mumbai. Some small-scale companies were identified anecdotally for refill of products such as cleaning goods (such as Refillable), but they were not found during CAP fieldwork. This is an opportunity to expand on reuse and refill systems for items that make the most sense economically and culturally.

COLLECTION

Findings: Several waste collection challenges were identified related to the cost of collection infrastructure and cost to consumers for collection. Issues related to waste segregation, regular open dumping in the city's water bodies (such as the Mithi River), collection needs for informal settlements along the river, and sanitation workers' rights also came up during field work. Many of these issues were tied to logistics, infrastructure, and human rights. The rapid growth of the city has left some critical needs around waste sorting and collection.

Opportunities

- Strengthen messaging around sorting at source and identify geographic areas of concern to focus on increasing household segregation.
- Improve and expand upon existing collection and sorting infrastructure, such as Dry Waste Centers and Material Recovery Facilities.
- Introducing and expanding upon plastic buyback programs, where citizens can exchange plastic waste for incentives (additional income), which encourages active participation in plastic waste management and promotes the concept of a circular economy.

END OF CYCLE

Findings: It is estimated that the city of Mumbai has an average daily waste generation of around 9,000 - 11,000 metric tons, equating to a per capita waste generation between 0.45 - 0.55 kg per day. Three primary waste processing facilities service the city but are insufficient for the high amounts of waste being generated and the increasing complexity of the material being discarded. Key infrastructure needs must be addressed and opportunities for innovative processing models and partnerships exist in the city.

Opportunities

- Investments could be made in setting up new treatment facilities, upgrading existing ones, and exploring composting technologies to harness the resource potential of the waste.
- Promoting private sector investment and entrepreneurial engagement in waste management can drive innovation and efficiency in waste treatment processes. Enterprises that have shown success in other cities, such as SWaCH (Pune) and Saahas (Bangalore).
- As a part of EPR initiatives and plastic buyback programs, producers can establish systems for collecting and recycling plastic packaging, thereby reducing the burden on municipal waste management systems.
- There is an opportunity to collaborate with non-governmental organizations (NGOs), citizen groups, and stakeholders to tackle plastic pollution collectively through joint awareness campaigns, clean-up drives, and adoption of sustainable waste management practices.
- The informal waste sector should be included in the system by collaborating with organizations

like Parisar Bhagini Vikas Sangh, who work for the welfare and livelihoods of female waste pickers.
- Continued research, monitoring, and evaluation of interventions is an opportunity to plan for, refine, and optimize waste treatment practices into the future.
- The city may want to explore a unified waste service by zone or ward to accommodate the diversity of waste across areas in Mumbai, instead of a heavily fragmented system with multiple providers in each zone or ward.
- The city may consider investing in specialized WM processes, particularly for problematic streams such as sanitary waste.

LEAKAGE

Findings: In total, 9,438 litter items were recorded across 27 100m2 transects in nine different square kilometer areas. Over 50% of all litter items were either Tobacco Products or Food Plastic items. The top five most common litter items observed were tobacco sachets, other tobacco packaging, plastic food wrappers, cigarettes (with plastic filters), and plastic bottle caps.

Opportunities

- The city could explore the prioritization of one ward or a select number of wards initially to implement litter prevention efforts, starting small to establish a model that can be further scaled.
- Expand outreach and education to instill an understanding of the detrimental consequences of littering, the importance of waste segregation, and the far-reaching effects of environmental pollution.
- Explore using a diverse range of monitoring methods, including field surveys and/or remote sensing to facilitate the identification of pollution hotspots and track the movement of plastic waste. These can help guide targeted cleanup endeavors, enable the monitoring of the effectiveness of waste management practices, and engage community members as active participants to foster ownership and collective responsibility.
- Enhance community outreach and messaging around open dumping, particularly in and around waterways, starting with a comprehensive review of the most vulnerable areas to focus on for pilot programs.

Strengths

- Many of the successful initiatives mentioned by interviewees included grassroots, community-based efforts, as well as efforts related to technology and education. Current examples of community initiatives include local organizations forming around issues related to air quality, the rights of the informal waste sector, menstrual waste, cleanups, and door-to-door education. Other strengths include people from other countries coming to

Mumbai to learn about sustainability and the advancement of technology. For example, some groups are using blockchain technology to value plastic (see more in the Community section).

- The MCGM has adopted a multifaceted approach to combat plastic waste, including: the establishment of a few dedicated centers for waste segregation and recycling, piloting Extended Producer Responsibility (EPR) and plastic buy-back initiatives, and initial awareness and educational campaigns to enhance public understanding of the importance of reducing plastic waste, promoting waste segregation, and adopting sustainable alternatives.
- Several non-profit organizations in Mumbai are actively involved in environmental conservation, ocean clean-up, and sustainable waste management. Some notable examples include Stree Mukti Sangathana, UNDP, RUR Greenlife, Global Alliance for Incinerator Alternatives (GAIA), Earth5R, Har Ghar Hara Ghar, Project Mumbai, Green Yatra, Afroz Shah Foundation, Sprout Sustainability, Green Communities Foundation (GCF), Akar Mumbai, Women Welfare Forum, and Mumbai Sustainability Centre.
- Many of these opportunities outlined in this report are in synergy with the report published by the India-Australia Industry and Research Collaboration for Reducing Plastic Waste, the National Circular Economy Roadmap for Reducing Plastic Waste in India (2023). The report summarizes that if the actions outlined in it are followed, by 2035, 80% of waste could be tracked digitally and then landfilling can be reduced by 30%, single-use plastics can be phased out over time, and recycling rates can increase to 67% (Dhodapkar et al., 2023).

Glossary of Acronyms and Abbreviations

BMC – Brihanmumbai Municipal Corporation
CAP – Circularity Assessment Protocol
CE – Circular Economy
CEE – Centre of Environmental Education
CIL – Circularity Informatics Lab
C&D – Construction and Demolition Material
DTDC – Door-to-door Collection
DWC – Dry Waste Centers
EPS – Expanded Polystyrene
EPR – Extended Producer Responsibility
HDPE – High-Density Polyethylene
GDP – Gross Domestic Product
IWC – Independent Waste Collector
LIP – Local Implementing Partner
MCGM – Municipal Corporation of Greater Mumbai
MLP – Multi-Layered Plastic
MPs – Microplastics
MSW – Municipal Solid Waste
MSWM – Municipal Solid Waste Management
NMI – New Materials Institute
OC – Ocean Conservancy
OWCs – Official Waste Collectors
PE – Polyethylene
PET – Polyethylene terephthalate
PP – Polypropylene
PPE – Personal Protective Equipment
PS – Polystyrene
RCN – Resilient Cities Network
SMS – Stree Mukti Sanghatana
SWM – Solid Waste Management
SWaCH – Sanitation, Water, and Community Health
TCI – The Circulate Initiative
TPD – Tons Per Day
UGA – University of Georgia
ULB – Urban Local Bodies

Introduction

Mumbai, the capital city of the state of Maharashtra, is often hailed as the financial, commercial, and entertainment capital of India. It is governed by the Brihanmumbai Municipal Corporation (BMC). With a population of over 20 million people, it stands among the world's top ten most populous cities. Situated on the west coast of India, Mumbai encompasses seven islands spanning 458 square kilometers (Figure 1). The city is bordered by the Arabian Sea and has three lakes (Powai, Tulsi, and Vihar), as well as four rivers (Mithi, Dahisar, Oshiwara, and Poisar) and four creeks (Malad, Mahim, Mahul, and Thane), all of which flow into the Arabian Sea. The Mithi River serves as a major outlet for the city's stormwater and wastewater.

Diverse communities, multiple spoken languages, and a variety of religions make Mumbai a dynamic cosmopolitan metropolis. It serves as the headquarters for multinational corporations, major financial institutions, and the Bombay Stock Exchange. Finance, entertainment, media, technology, and manufacturing drive the local economy. Bollywood, the renowned Hindi film industry, has greatly shaped the city's cultural and economic landscape.

Mumbai attracts many tourists because of its landmarks, street markets, and lively atmosphere. A few of the city's notable attractions include the Gateway of India, located adjacent to notable landmarks such as the Taj Hotel, Marine Drive, Chhatrapati Shivaji Maharaj Terminus, the Siddhivinayak Temple, Colaba Causeway, and Crawford Market. Mumbai's street food scene is renowned, with items such as vada pav, pav bhaji, and bhel puri all readily available for consumption and are popular among locals and visitors alike.

Figure 1: Geographic Location of Mumbai in India

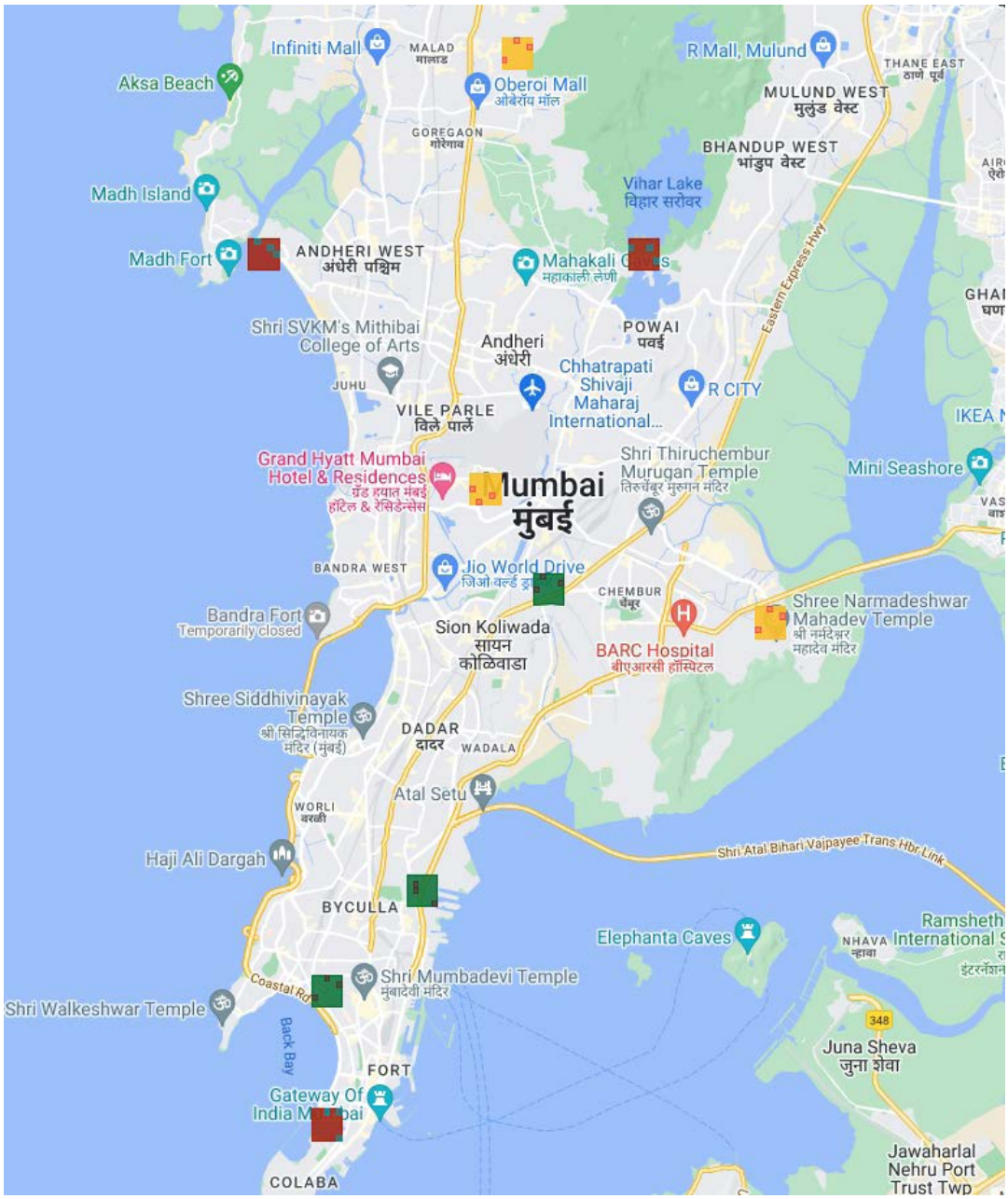
Mumbai faces a range of challenges commonly encountered by rapidly growing megacities. Overcrowding, aging infrastructure, and pollution are among the prominent issues. These challenges arise from the combination of a relatively high per capita waste generation rate (0.85 kg/day) (CPCB, 2018) compared to the average waste generation rate in India (0.57 kg per capita per day (Kaza et al., 2018)) and the increase in plastics and rubbers in the Indian waste stream over the past decades (Joshi et al., 2016). Waste management infrastructure cannot grow fast enough, resulting in collection issues and solid waste accumulating in various areas. Monsoons and flooding further the challenge of managing solid waste, particularly during the rainy season. Moreover, Mumbai's high population, in addition to its vulnerability to rising sea levels and flooding, places it among the top Asian cities at risk of coastal flooding (MCGM, 2022).

The Government of India has adopted a multifaceted approach to combat plastic waste, including bans (plastic items include, ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice- cream sticks, polystyrene (Thermocol) for decoration, plastic plates, cups, glasses, forks, spoons, knives, straws, trays, wrapping or packaging films around sweet boxes, invitation cards, cigarette packets, plastic or PVC banners less than 100 micron, and stirrers (PIB Delhi, 2022).These items are deemed unnecessary yet have a high potential of becoming litter. Recent regulations have made it illegal to produce, import, stock, distribute, or sell certain types of plastic (The Associated Press, 2022), and have also encouraged the establishment of dedicated centers for waste segregation and recycling, the implementation of Extended Producer Responsibility (EPR) and plastic buy-back initiatives, and the execution of awareness campaigns and educational programs to enhance public understanding of the importance of reducing plastic waste, promoting waste segregation, and adopting sustainable alternatives. Furthermore, several non-profit organizations in Mumbai are actively involved in environmental conservation, ocean clean-ups, and sustainable waste management. Some notable examples include Stree Mukti Sanghatana, Greenline, Green Yatra, Afroz Shah Foundation, Sprout Sustainability, and Mumbai Sustainability Centre.

The India-Australia Industry and Research Collaboration for Reducing Plastic Waste published the National Circular Economy Roadmap for Reducing Plastic Waste in India in December 2023. This comprehensive report provides the need for such a roadmap and covers seven elements of the circular economy for plastics in India. These include: Production, Consumption, Recycling, Awareness and readiness, Consistent compliance, Supportive infrastructure, and Commercial viability (Dhodapkar et al., 2023). Each section outlines the priorities which include: developing products that can be recycled, allowing consumers to choose to not use single-use plastics, promotion of closed-loop recycling (reducing virgin plastics use), encourage small businesses to work in the plastics space, systemic engagement and open/transparent data, and investing in physical and digital infrastructure (Dhodapkar et al., 2023). Many of these components are in synergy with UGA's Circularity Informatics Lab (CIL) and Circularity Assessment Protocol (CAP). The report summarizes that if the actions outlined in it are followed, by 2035, 80% of waste could be tracked digitally and then landfilling can be reduced by 30%, single-use plastics can be phased out over time, and recycling rates can increase to 67% (Dhodapkar et al., 2023).

As one of the cities in the second Urban Ocean cohort, Mumbai 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 a local implementing partner (LIP) - The Centre for Environmental Education (CEE) based in Pune, India - to conduct a circularity assessment of the city.

Figure 2: CAP sampling areas in Mumbai



By population size category (Red = low population; Yellow = middle population; Green = high population)

The Circularity Informatics Lab at the University of Georgia has developed a Circularity Assessment Protocol (CAP), 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 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, among others. 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 2023, CAP has been conducted in 51 cities in 14 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 program. Background information and a literature review were conducted in December 2022. Fieldwork was conducted from January - May, 2023. 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 cities.

CAP Findings

Input

To get a snapshot of the characterization, scope, and source of common plastic packaged items that are entering Mumbai, samples of common convenience items, also called fast moving consumer goods (FMCG), were sampled within nine 1km2 transects in Mumbai - three within each tertile (relative groupings of high, medium, and low) of the population count. The LIP selected 3 convenience or grocery shops to sample within each 1km2 transect area. For each shop, the LIP collected the most popular brands of beverages, candy, chips, and tobacco products (including chewing tobacco, cigarettes, and sachets). The most popular brand was determined based on the brand most frequently observed upon shelf inventories and/or the shopkeeper's input. Overall, the total number of product samples total 161; unique FMCG collected and sampled were 27 beverages, 28 candies, 28 chips, and 78 tobacco (Figure 3).

Figure 3: Convenience store sampling in Mumbai

(Photo Credit: CEE)

For each of the products documented, the type of packaging (including polymer, if possible), the brand, and the parent company were noted. From the packaging, the team was able to determine the manufacturing location from 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). Manufacturer and parent company distances (Table 1) are intended to estimate the distance in kilometers between the city and the manufacturer or parent company of each

product. All (100%) of FMCG in Mumbai were manufactured domestically in India (Figure 4). The closest manufacturing to Mumbai is for tobacco sachets, followed by chips, then beverages and chewing tobacco at approximately an equal distance away. These are followed by cigarettes and then candy, which is the item manufactured the furthest from Mumbai. Parent companies of the FMCG were both domestic and international (Figure 5).

Table 1: Distances from sampled stores to convenience products parent company and manufacturing facilities

	Distance Store to Parent Company (km)				Distance Store to Manufacturer (km)			
	Minimum	Maximum	Average	Median	Minimum	Maximum	Average	Median
Beverages	1	12,512	1,731	1,121	1	1,126	456	437
Candy	4	13,150	4,794	4,652	104	1,516	789	957
Chewing Tobacco	42	1,655	668	654	0	1,263	590	438
Chips	0	12,512	3,324	419	31	1,635	638	358
Cigarettes	8	13,011	4,346	4,444	0	1,697	1,512	668
Sachets	3	12,965	3,550	5	7	1,374	567	133

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

Figure 4: Map of Manufacturer Locations by Convenience Product Type

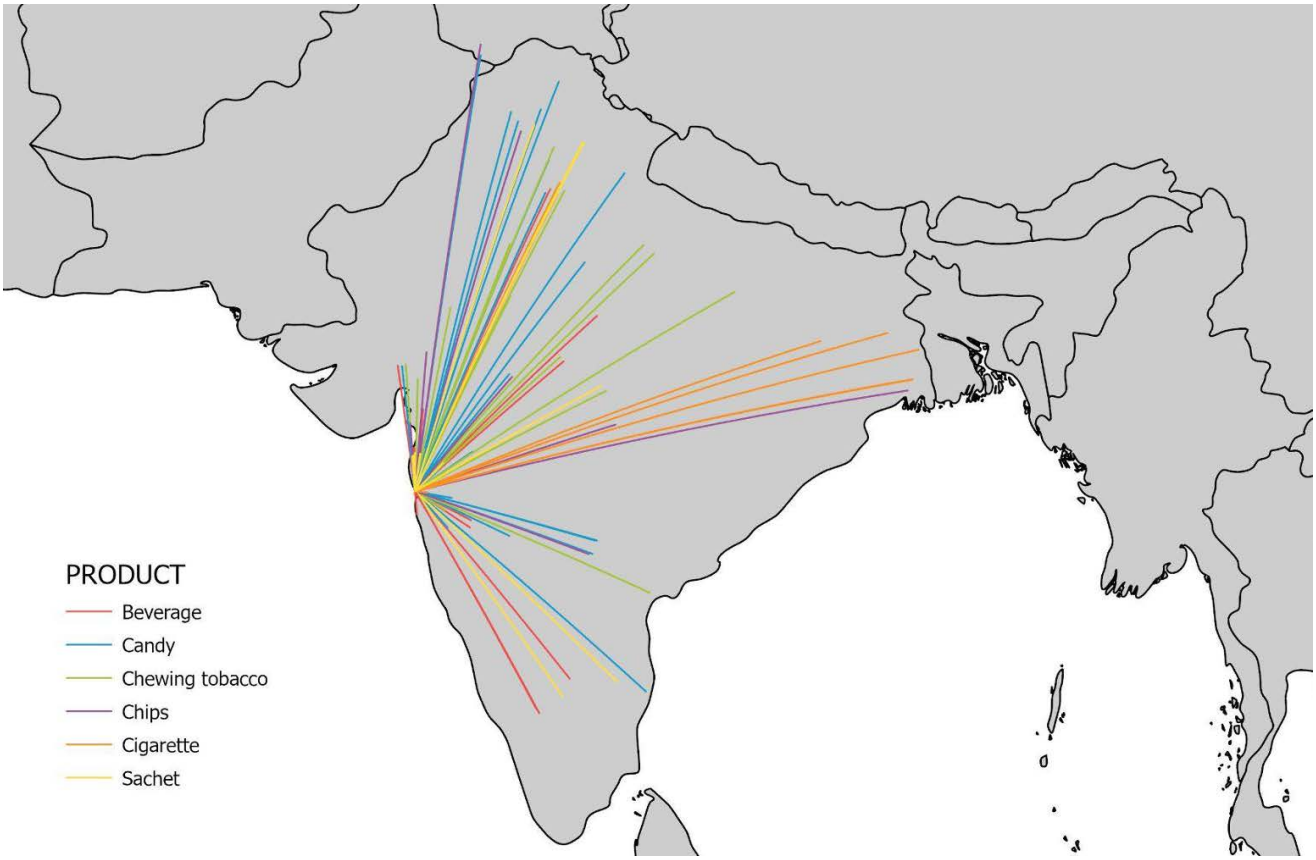
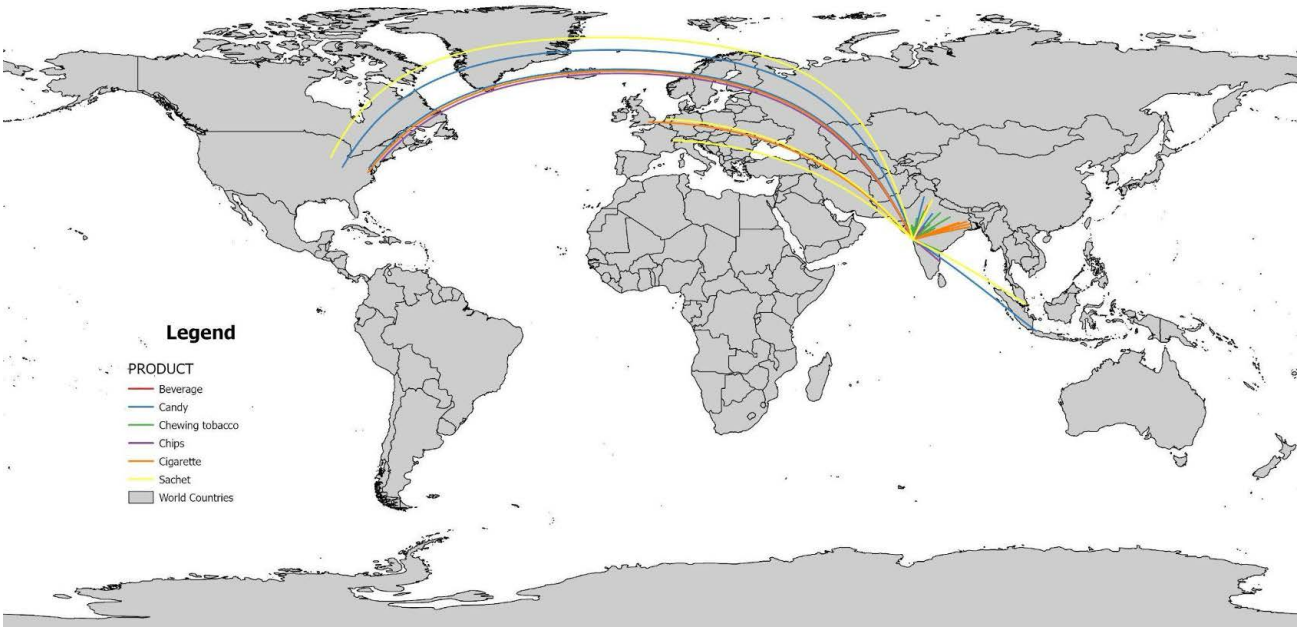


Figure 5: Map of Parent Company Locations by Convenience Product Type



While parent companies are both domestic and international, the fact that 100% of the products are manufactured within India, which has national EPR strategies, provides the potential for conversations with domestic manufacturers about circularity, reuse v. single-use, and packaging materials and design. Based upon research conducted by CIL for the Surat CAP, the following information was found on EPR in India: Under the national Plastic Waste Management Rules of 2016, India's Ministry of Environment, Forest and Climate Change (MoEFCC) proposed a national framework for EPR, building on previous definitions from the Plastic Waste (Management and Handling) Rules of 2011. These rules first defined terms such as waste collectors, multilayer plastic, and EPR. Expanding upon these definitions, the EPR 2016 framework specifies that waste collection and segregation programs are to be managed by Urban Local Bodies (ULBs), while sharing infrastructure costs with manufacturers, importers, and users. By this framework, the central government sets the policy expectations and the states are charged with implementing them through the state-level Pollution Control Boards (PCB). Accordingly, local companies must report to these entities. Further, plastic packaging companies must register with the PCB as a "producer," "brand owner," or "importer" and share information on the types of plastics and products manufactured and distributed. In turn, the registration system provides utility in ensuring that local waste management systems meet local needs and acts as a balance sheet for checking that equivalent amounts of plastic are being collected and processed. Further, companies operating in only one state are required to register with the corresponding state PCB. However, companies that work across state lines must submit EPR Action Plans to the state PCB as well as the Central Pollution Control Board (CPCB) at the national level (MoEFCC 2020).

The framework also proposes three EPR models — a fee-based model, a Producer Responsibility Organization (PRO) based model, and a plastic credit model — all of which the framework states could be part of EPR implementation in India. The fee-based model requires producers, importers, and brand-owners (PIBs) that use a certain quantity of plastic packaging to contribute a fee to an EPR Corpus fund that will be set up by the Government of India. The fee would be based on the quantity of plastic waste generated compared against funding required by ULBs to handle plastic waste. Funds would be disseminated to ULBs for the use of waste handling, collection, segregation, treatment, and processing. The second model suggested is a PRO based model where PIBs can engage a PRO to collect, process and recycle a certain quantity of waste based on the required target. Through the plastic credit model, PIBs can purchase credits from accredited recyclers to ensure that equivalent amounts of packaging waste produced has been recovered or recycled (MOEFCC 2020). At the time of their release, the Plastic Waste Management Rules of 2016 were praised for clear definitions and thorough requirements for meeting EPR goals throughout the country. However, critics have cited that the EPR Guidelines call for inconsistent levels of implementation, omission of some of the most problematic plastics, and lacking inclusion of the informal waste sector (Chandran 2021).

Additionally, India also has their own Plastics Pact https://www.indiaplasticspact.org created with guiding principles from the Ellen MacArthur Foundation (EMF) Plastic Pacts Network. India's Plastic Pact is managed by the Confederation of Indian Industry and CII-ITC Centre for Excellence for Sustainable Development and is supported by WRAP with funding from UK Research and Innovation and Stewart Investors. India's Pact aims to, "promote collaborative action to enable innovative solutions to change the way plastics are designed, produced, used, and disposed." The following targets are listed as 2030 goals on the Pact website:

1. Define a list of unnecessary or problematic plastic packaging and items and take measures to address them through redesign and innovation.
2. 100% of plastic packaging to be reusable, recyclable or compostable (These would only include compostable

plastics with all the following properties, a. do not leave any microplastic residue, b. used in closed-loop and controlled systems with sufficient infrastructure available or fit-for-purpose applications, and, c. properly labeled as 'Home' or 'Industrial' compostable).

3. 50% of plastic packaging to be effectively recycled.
4. 25% average recycled content across all plastic packaging.

Community

To understand current attitudes and perceptions of plastic waste, semi-structured interviews were conducted with 15 key stakeholders (Table 2). The interviews aimed to elicit participant perceptions of plastic and waste management in the Mumbai community as well as provide insight into specific challenges, observations, and needs that relate to the participants' specific backgrounds. Among those interviewed, four were NGO representatives, three were informal waste representatives, two were private waste company representatives, two were local business representatives, one was a private industry representative, one was a local resident, one was an academic, and one was a former government representative.

Table 2: Stakeholder Groups and Number of Interviews

Stakeholder Group	Interview Count
NGO	4
Informal Sector	3
Private Waste Company	2
Local Business	2
Private Industry	1
Local resident	1
Academic	1
Government	1
Total	**15**

Introduction/Overview

Interviewees shared their frustrations with solid waste management challenges including polluted water, sewage, and social inequalities (Figure 6). According to interviewees, waste disposal challenges included illegal dumping and incineration, and waste collection challenges involved cost, segregation, and workers' rights. Interviewees' perceptions of the general public's education and awareness of waste, recycling, and other circular economy topics were mixed. Regardless of the obstacles and barriers shared, interviewees had no shortage of ideas on proposed solutions and opportunities. Interviewees remain optimistic about current community initiatives, shifts to alternatives, and interest among young people, among other solutions and opportunities.

Figure 6: Stakeholder interviews

(Photo Credit: CEE)

General Solid Waste Management Challenges

Interviewees shared their thoughts on general solid waste management challenges, including waste and other materials making their way into waterways, as well as how waste is prevalent in low-income areas. One interviewee even noted how the COVID-19 pandemic affected waste.

Waste in Waterways

Interviewees tended to feel dejected about the prevalence of waste in waterways, often citing the prevalence of plastics within these areas:

> **"You feel sad. Yes, you feel emotional [thinking about], 'this is how a river can be.' It's**

> **unbelievable. It's so much plastic... So, we had this large [net for sampling], and you would put this [net] in the water and just get plastic...Nothing else. No fish. Fish can't survive."**
>
> **— NGO Representative**

> **"And the problem we face is that India has a very long coastline, and this issue of marine litter is widespread everywhere... I don't know what the solution is; we are not aware of it. But in reality, when I was trying here, I haven't found a solution yet."**
>
> **— NGO Representative**

> **"During weekends, there is a significant increase in crowds. Consequently, there is a substantial amount of plastic waste, particularly in areas like marine lakes. We find a lot of thermocol, fishing nets, flip-flops, clothes, and school bags littered there."**
>
> **— NGO Representative**

> **"And then [it is] difficult to rescue [people who fall in the river]. Because it's so impossible to rescue [them]. When somebody falls in that [Mithi] river, there's so much plastic that your legs get entangled in the plastic. It goes down and then it's not plants, you know, it's plastic. So, once it is entangled, you cannot come out of it and you lose breath and so many things happen. So, you fall in that river, you're dead. And if you survive, you will die of diseases later on."**
>
> **— NGO Representative**

Sewage

When speaking about the prevalence of waste in waterways, issues related to sewage were also brought up:

> **"Literally, Mumbai is surrounded by sewage. We need twenty-five sewage dumping grounds, more than our garbage. Sewage is entering into our food chain... And there is a very simple technology available, like [in] Oslo, where the entire sewage is running their buses. So, we have the potential to create value out of the sewage."**
>
> **— Academia Members**

> **"Ever since it flooded, contracts worth crores [10 million] of rupees have been issued to clean the Mithi river and the waste is dumped again and removed again, which is a big business in the municipality.... In my childhood, we used to go for walks near the Mithi river. I mean, that river was so beautiful! It's the same with all the rivers, but it's a sewer now, and there are a lot of chemicals from Kanpur where it comes from."**
>
> **— Informal Waste Representative**

> **"There's a river called Poisar, and I used to swim in it when I was young. We had lotus flowers, but now it's a sewer because of nearby buildings and sewage being [illegally] dumped there. It hurts us. We don't know how much anger we have... Because we have seen living water turn into a sewer."**
>
> **— Academia Members**

> **"Now, there are buildings in Mumbai, near about fifteen to twenty percent of them have no connection to the sewage line, and they have septic tanks. These tanks need to be emptied every five to ten years...people die while cleaning the tanks, and these buildings belong to the poor, so who will compensate them?"**
>
> **— Informal Waste Representative**

COVID-19 and Waste

COVID seemed to exacerbate existing waste issues. One interviewee mentioned that COVID-19 impacted both employment and the amount of waste created:

> **"During the COVID pandemic, many people were left unemployed, and there was a lot of waste on the streets, including clothes and food."**
>
> **— Informal Waste Representative**

Education and Awareness

Interviewees' views on the willingness of local communities to participate in waste management, recycling, and composting varied. One interviewee mentioned how class played a role in willingness to participate:

> **"In *The Politics of Sanitation in India* by Susan Chaplin, [Chaplin says that] in India, the middle class detaches itself from the work of cleanliness. They have a mindset that it's not my job, it's somebody else's job, someone who is part of the lower class. So, they leave the work of cleanliness to them. The next generations will do it...We are facing great injustice here."**
>
> **— Former Government Representative**

Current Education Programs

There are already several organizations within Mumbai that have been working on education and outreach, including door-to-door outreach efforts and targeted training at schools. These efforts are shown below:

> **"Yes, we trained the door-to-door collection staff and the [house help] working in households. We also conducted door-to-door waste segregation awareness...Yes, each group received specific training. It was a very focused effort."**
>
> **— NGO Representative**

> **"It's difficult to [change] people's mentality, especially the Indian mentality. It's easier to inspire one or two inspired individuals, and they can inspire others. That's why we have an approach where we try to focus on schools, because students have a fresh mentality, and they are easy to change. They are ready to be inspired rather than going to someone who is 60 years old or 30 years old."**
>
> **— Private Industry Representative**

Some interviewees felt that there was a lack of awareness when it came to waste management issues:

> **"Two or maybe one person out of ten [people living in slums along Mithi River] will say there's waste, but most of them don't even think about it...It's a lack of awareness. They consider it normal; this is their normal..."**
>
> **— NGO Representative**

> **"[People] even throw garbage on the bodies of the municipal workers through the window. It's all house alleys. There's a lot of garbage in those house alleys. I mean, it's about educating people, explaining it to people."**
>
> **— Informal Waste Representative**

Education Challenges

Interviewees emphasized the need to partner education with broad structural changes, as well as changing social and economic perceptions of how waste, and those who work with it, should be valued:

> **"The biggest challenge is to create such rapid awareness and then supplement it with the system so that the garbage doesn't go to the wrong place... So, awareness and capacity building is first. The second one is the training of the support staff."**
>
> **— Academia Members**

> **"IEC [information, education, and communication] should be actively done. Engage people, and you need to show the value of waste pickers so you know why they are essential."**
>
> **— NGO Representative**

> **"These people were throwing away a lot of plastic, which is valuable. They didn't know that these kinds of plastic can also get recycled. There are organizations in Mumbai [and] all over the world that have values for everything. They didn't know. ...So, they were only collecting PET bottles."**
>
> **— NGO Representative**

> **"We partnered with an NGO for this campaign, and they gave us a report that in all these years, no one had ever talked to [people living in slums along Mithi River] about constant [regular] collection. This discussion has just started."**
>
> **— NGO Representative**

Strengths

Although interviewees mentioned several challenges related to waste disposal, collection, and education and awareness, the strengths of Mumbai's waste system can be summed up by the current community initiatives, the interest of community members in having an equitable system and addressing inequalities, as well as the proposed solutions and opportunities provided by interviewees.

Current Community Initiatives

Many of the successful initiatives mentioned by interviewees included grassroots, community-based efforts. One interviewee spoke about how the founder of a local organization began experiencing respiratory issues when a nearby dumping ground caught on fire; this galvanized their interest in individual household waste management. Other sentiments are shown below:

> **"People are coming from many countries to learn about sustainability. So, in the process they would come as interns and when they go back to their country, they would launch programs over there. So that's how you're able to scale out."**
>
> **— NGO Representative**

> **"We give value to every piece of plastic using blockchain technology and with this we set up an entire community so people would clean every day, they would collect the plastic and they**

were paid on a per kilo basis. Apart from that, when they're selling that plastic, we connect the entire supply chain. When they're selling the plastic, they're getting paid."

— NGO Representative

"The government was giving [informal waste workers] wheat and rice, while we gave them oil, onions, potatoes, pulses. We did this. [We also] distributed safety kits."

— Informal Waste Representative

"We fought with a lot of global governance at the local level, national level, international level, and so on. And, then they said, 'If you are saying 'no' to incineration, then what is the alternative?' So, then we said, 'Zero waste is an alternative. It is scalable, it is community led and it is practical and cheap, it has all the benefits which an incinerator does not provide.'"

— NGO Representative

"[One organization has] a program on menstrual waste where they work with educating women and switching them to menstrual cups. This is quite active in Thane. They visited nurses in various medical centers, and educated them. Then nurses start using it."

— NGO Representative

"It's a long battle [getting rid of multilayer plastic]. But what we see is that there is also hope. There are good solutions also coming up. The organizations are growing, they are doing what they can."

— NGO Representative

"We have a network of at least 850 CBOs (community-based organizations). We work under the name Swachata Sanvardhan Swa-Santa Mahasangh." This is a grassroots organization that works towards cleanliness and sanitation."

— Former Government Representative

"In fact, to a certain extent, we even used to monitor the city. We would go door to door, opening the waste bags, telling them what is right and what is not. We did all that to get [residents] used to it. So, by the end of one month, they would get used to it, and around 90% segregation would be achieved."

— Private Waste Company Representative

"There are 10,000 houses in Anushaktinagar. It's all zero waste. There is also dry waste

disposed of and wet waste biogas. There are three plants and composting, and employ about 51 people."

— Informal Waste Representative

"So, the green and moral economy talks about everybody being taken care of. Everybody has been given an opportunity, and that is what we teach. So, one of our green entrepreneurs, who graduated from our training, has taken six workers and given them jobs to create the products that she wants. Now they have an optimistic life. That's how the society will evolve, the golden age of people..."

— Academia Members

"But I have also seen a lot of the places where [waste segregation] has been done correctly because of very passionate people who wanted to do it and make sure that it gets done. It's a citizen's collective effort."

— Private Waste Company Representative

"So, we have these organizations who are demonstrating that zero waste is possible, you do not need these fancy technologies which are very costly and are highly polluting. These are the problems and that's why this waste program was initiated: because everyone is like, 'kay, we understand you are against incineration. But you tell us an alternative...We need a solution. That's why one of our focal programs is zero waste."

— NGO Representative

"...Initially when we used to manage waste at festivals, we would segregate waste, and have different categories. It was then difficult to find where to send these, because there weren't too many dry waste collection centers at that point. Now, a lot more dry waste collection centers have opened up, specifically in Mumbai, which are so much more accessible...We have also put together a dry waste collection centers map for Mumbai so that if individuals want to send that dry waste from their homes, they can send it to the facilities."

— Private Waste Management Representative

Shift to Alternatives

A couple of interviewees felt that there is a general move toward alternatives:

> **"There are still some places where plastic straws are used, but in many places, there has been a shift to paper straws."**
>
> **— Private Industry Representative**

> **"And, because of the plastic ban, in fact there has also been a rise in the availability and the number of people who are producing [compostable plastics] now. ...So, now the availability of alternatives is there. So, it's much easier for people to adopt this."**
>
> **— Private Waste Management Representative**

Interest Among Young People

Some interviewees shared their optimism about younger generations being interested in waste management issues:

> **"Events where the demographics are mostly, GenZ or millennials, who see and care about [environmental issues], are also trying to be more conscious and are trying to become more plastic free or zero waste, because they know that their demographic audiences care about these things. That's another change with that."**
>
> **— Private Waste Management Representative**

> **"We have seen that young people are much more impressionable and are actually much more aware than the adults in the society. And, they actually have the power to drive change."**
>
> **— Private Waste Management Representative**

Interest in Addressing Culture

Other interviewees shared their thoughts on how awareness relates to cultural and social attitudes and practices:

> **"We need to understand the cultural issues surrounding cleanliness, and in that, we have all learned a lot from the mosque and community action. We have two teams, and we need to learn by doing, not by lecturing. People don't want to be taught; they want to learn. And nobody taught them. We need to instigate curiosity and awareness among them."**
>
> **— Former Government Representative**

Proposed Solutions/Opportunities

Interviewees had many ideas about opportunities for change, including maintaining a decentralized approach a list of local resources and organizations, Extended Producer Responsibility (EPR), and others:

> **"[What] all these projects have in common is the decentralization of many processes. Make it local. Again, making it local has many advantages. First, local communities become relevant for [communities] and [people] need to be somewhat incentivized to do so."**
>
> **— NGO Representative**

> **"I think more political will [is necessary]; having conversations with political leaders and increasing enforcement will help. You can take a look at certain areas in Pune or Mumbai, which are far cleaner and litter free than other areas. So, having more awareness and more social norms around how you can keep areas litter free. How segregation can help advance all of these measures. I think that's something that could be improved."**
>
> **— Private Waste Management Representative**

> **"Actually, a [list of waste collection/management service providers] could be quite useful. I know even in Bangalore, the local municipality has a list of service providers for dry waste collection centers. So that's very useful. Unfortunately, there aren't too many players offering zero waste services at the moment for events….Now, we are seeing more and more players coming in. So, perhaps in the next two or three years there will be a lot more folks who will be offering zero waste services for events."**
>
> **— Private Waste Management Representative**

> **"I think one thing [BMC] could do better is they could partner with more organizations in terms of training services, because currently they are not actively involved in training. They are more busy with infrastructure…"**
>
> **— NGO Representative**

> **"We are declaring that [plastic] is the top pollutant in front of you. So, that is a way for us to fight more to get that evidence and have that data ready with us with which we can campaign and use with local governments. So, when we say that these are the top polluters, then Coca Cola is pressured and Hindustan Unilever is pressured…"**
>
> **— NGO Representative**

> **"I have a strong case in EPR that you should engage with waste picker-based organizations only. Like, as much as possible…. In Mumbai, you go with SMS. I think Bisleri is doing that with**

> **SMS. So, what happens is that you are not taking away the waste from waste pickers. They are getting proper sorting centers, and [EPR] is building it for them."**
>
> **— NGO Representative**

> **"From this plastic waste, we can create threads and then turn them into products, generating income. We have brought this plastic waste into the village and turned some of it into products that can be reused and have various uses. So, we need to convert them into a circular economy model."**
>
> **— Former Government Representative**

> **"Housekeeping agencies [need to be engaged]. There is a lot that needs to be done with housekeeping agencies where we should be able to train the housekeeping agencies themselves. … Wet waste cannot go in the dry waste. Dry waste cannot go in the wet waste."**
>
> **— Private Waste Company Representative**

Interviewees shared their frustration with challenges related to solid waste management, including disposal, collection, and education and awareness. However, interviewees had no shortage of proposed solutions and opportunities. Interviewees tended to express sadness when discussing the prevalence of waste in the environment, specifically waterways and sewage, and they also tended to relate waste to larger issues related to income and workers' rights. Interviewees felt that opportunities for change lie in decentralized, grassroots movements as well as other solutions, including EPR.

Product Design

To characterize material types used in common consumer plastics, samples of common convenience and to-go items were obtained as described in the Input section (Figure 7). The LIP collected samples from stores and restaurants when they were located in each of the nine 1km2 transect areas. The average mass of both the packaging and the product itself were collected for 161 samples (Table 3). Chewing tobacco was added as a separate category for product analysis in Mumbai as they were an abundant proportion of goods sold in grocery stores and shops throughout the city.

Figure 7: Example of stores (left) and FMCG products (right) sampled in Mumbai

(Photo Credit: CEE)

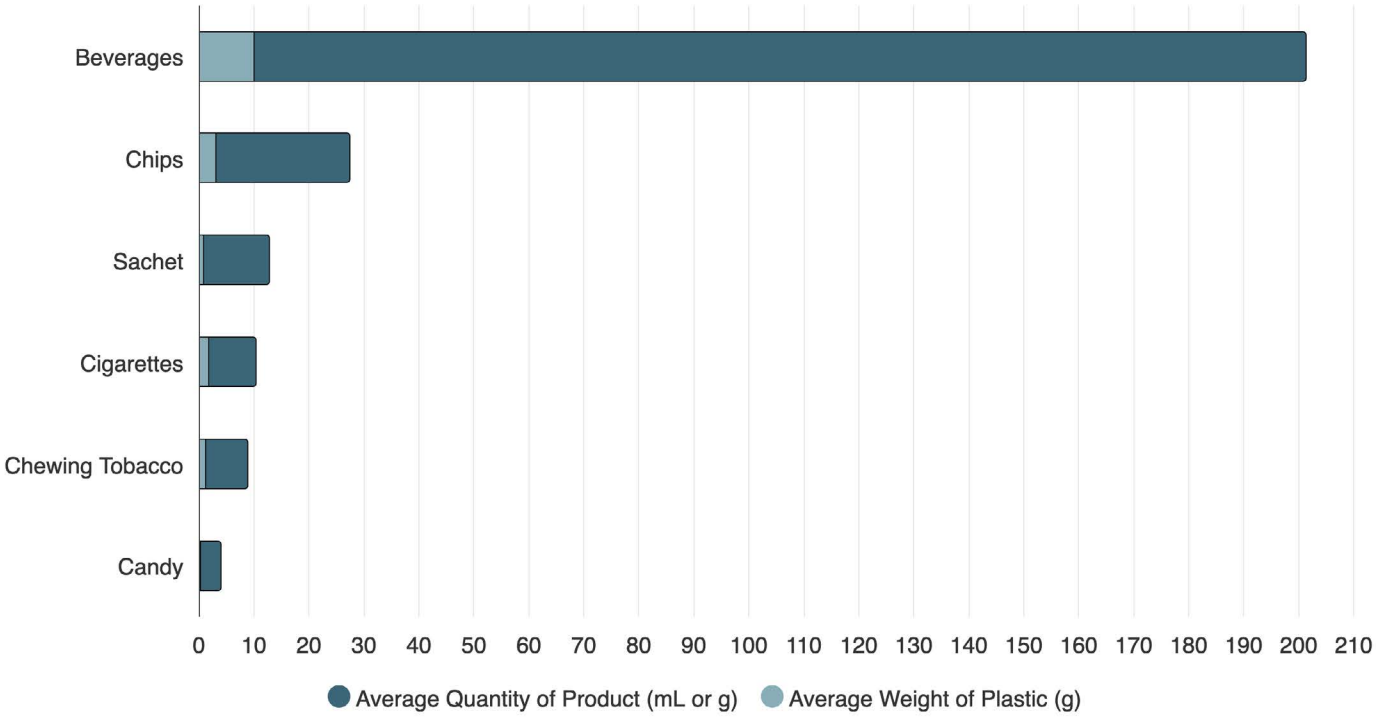
The average weight of both the packaging and the product itself were collected for all of the 161 samples of top items from 18 grocery and convenience stores. Across the six product categories, the average weight of plastic packaging ranged from 0.19 g for candy to 10.04 g for beverages, with an average weight of 2.87 g (Table 3). The high mass of beverage bottles was likely due to the high-density properties of PET relative to other plastic materials. The candy had the lowest mass of plastic packaging likely due to the small format. The average product weight similarly ranges from 3.84 g among candy and 191.36 among beverage bottles (Table 3). Like the packaging itself, the high product mass associated with beverages was likely driven by the density of liquid products. Products packaged in candy, however, are small quantities that would not lead to heavy mass relative to the other product formats.

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

Product Type	Product Count	Average Quantity of product (g or ml)	Average Quantity of Packaging (g)
Beverage	27	191.36	10.04
Chips	28	24.36	3.05
Sachet	25	11.93	0.88
Cigarettes	24	8.53	1.86
Chewing Tobacco	29	7.75	1.17
Candy	28	3.84	0.19
Grand Total	**161**	**41.52**	**2.87**

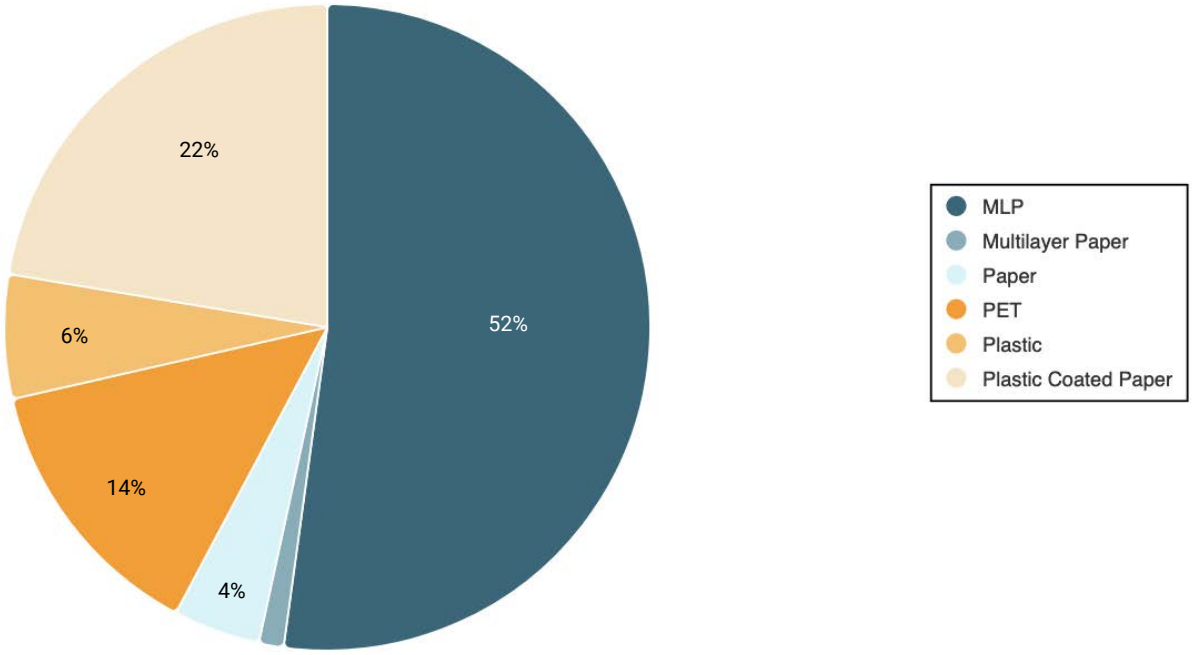
Given these discrepancies in packaging and product masses, the surveys also determined that beverages had the highest product-to-packaging ratio, while candy had the lowest. This ratio highlights how small quantities of products sold in candy have disproportionately high packaging mass. In other words, more packaging is needed for products sold as candy in comparison to the other product categories in which the products had higher masses relative to their packaging. Because of the density of liquid, beverages had the largest product-to-plastic packaging ratio, representing a more efficient format of product delivery (Figure 8).

Figure 8: Convenience Store Plastic to Product Ratios, shown in grams



Among the top brands in convenience store samples, there were six different categories of materials observed (Figure 9). Multi-layered plastic (MLP) film was the most abundant material type for packaging, making up 52.2% of the surveyed items. Plastic-coated paper was the next largest category of common packaging material with 22.4%. Overwhelmingly, the top consumer products were packaged in multi-material packaging such as MLP and multilayer paper, which can make it difficult for sorting and waste management, both from the consumer and the practitioner's perspective.

Figure 9: Material Breakdown of All Convenience Items



MLP = multilayer packaging; PET = polyethyl terephthalate

To-go ware from food vendors and restaurants

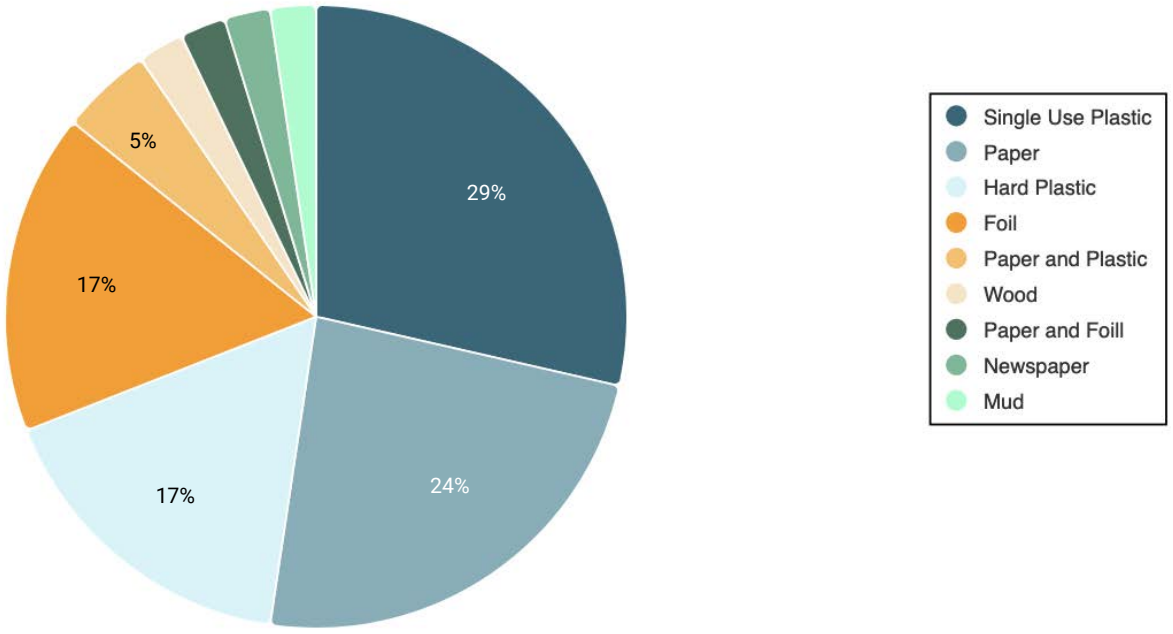
In addition to the convenience items, within each of the selected nine 1km2 transects in Mumbai, the LIP visited randomly selected food vendors and/or to-go restaurants to sample the food packaging and utensil types that were being distributed (Figure 10). Nine vendors were sampled in total. The LIP collected 42 to-go items from those vendors and documented their weight, material type, and brand, where possible.

Figure 10: Example of food vendor sampled in Mumbai

(Photo credit: CEE)

Among the to-go items sampled in Mumbai, there were multiple types of materials identified. However, plastics were predominantly provided by the surveyed businesses, making up 50% of the collected items by count. Of these plastics, formats included single-use plastic bags, utensils, straws, and containers, hard plastic containers, and paper and plastic plates and containers. Within the material groups, the most common plastic material was single-use plastic, which made up 28.6% of items, followed by paper (23.8%), and hard plastic (16.7%) (Figure 11).

Figure 11: Material Breakdown of To-Go Items from Food Vendors and Restaurants



The average mass of items ranged from heavier clay (including mud) (162 g) items to lighter weight foil, paper, and single-use plastic items (some around 1g) (Table 4).

Table 4: Material type and average weight of common packaging items from food vendors in Mumbai

Product / Material	Total Sample Count	Average Mass of Packaging (g)
Bag	**8**	**2.46**
Paper	1	10.10
Single-use plastic	7	1.37
Bowl	**2**	**2.64**
Foil	1	1.74

Product / Material	Total Sample Count	Average Mass of Packaging (g)
Hard plastic	1	3.54
Container	**14**	**9.08**
Foil	6	5.68
Hard plastic	5	14.55
Newspaper	1	1.64
Paper and plastice	1	4.80
Single-use plastic	1	13.79
Cup	**8**	**21.93**
Mud	1	162.00
Paper	6	1.94
Single-use plastic	1	1.83
Plate	**5**	**5.59**
Paper	3	5.58
Paper and Foil	1	5.51
Paper and Plastic	1	5.70
Straw	**1**	**0.25**
Single-use plastic	1	0.25
Utensil	**5**	**1.10**
Hard Plastic	1	0.63
Single-use plastic	2	0.96

Product / Material	Total Sample Count	Average Mass of Packaging (g)
Wood	2	1.49

All item categories, which are typically designed for single-use and immediate disposal, had some form of material alternative to plastic. These alternatives were mostly paper used for cups, plates, straws, and bags, wood used for utensils, mud used for cups, and newspaper used for food wrapping (Table 5).

Table 5: Alternative Foodware Available in Mumbai

Product	Alternative Sample Count	Alternative Material(s) Found
Cup	7	86% paper, 14% mud/clay
Bag	4	100% paper
Straw	3	100% paper
Utensils	2	100% wood
Plates	2	100% paper
Food Wrapping	2	100% newspaper
Total	**20**	

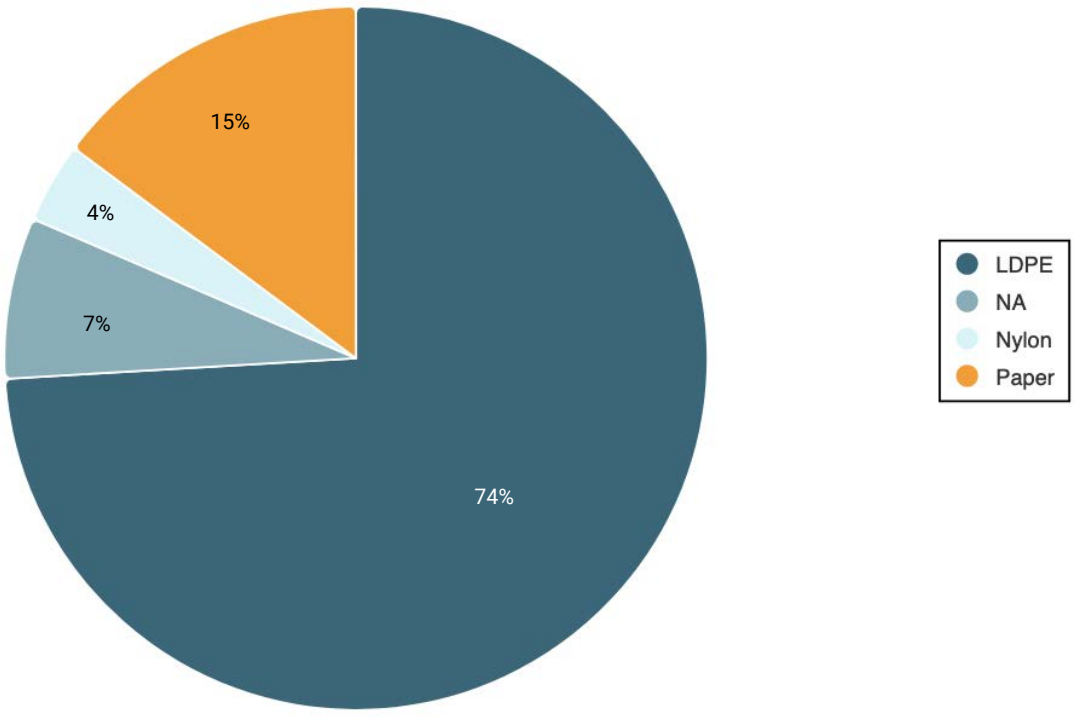
Notably, there were no recorded plastic items that were labeled as biodegradable (a problematic label) or oxo-degradable (a problematic property), suggesting that shops and vendors may not be using these types of material alternatives. While plastic alternatives that are considered compostable may provide a viable solution, they rely on appropriate infrastructure to ensure proper collection, segregation, and treatment of the material. As such, misleading nomenclature and lack of clear labeling on the different types of plastic can cause confusion, particularly labels such as biodegradable, compostable, oxo-degradable (Moss 2017).

Use

To investigate the distribution and use of disposable plastics, material alternatives, and reuse options, the LIP surveyed 27 shops to determine the typical distribution of carrier bags to consumers. Most shops (n = 20) provided single-use plastic bags at no cost to the customers (Figure 12, Figure 13), directly in opposition to the national and state-wide policies targeting bans on plastic bags. One restaurant and three pan (convenience) shops distributed paper bags to customers. While bag thickness was not recorded, the mass of the surveyed single-use plastic bags ranged from 0.7 to 14.83 g, with a mean mass of 4.39 grams. Stores and kirana (grocery) shops had the highest mean mass of plastic bags (5.49 g), while pan shops had the lowest mean mass (2.78 g). Two shops offered no to-go bags at all (shown as "NA" in the chart below).

Notably, the LIP surveys reported no alternatives to plastic bags or policies encouraging reusable bag use. This indicates that existing adoption and/or enforcement levels need to be increased.

Figure 12: Bag Survey from Convenience Stores & Food Vendors



The Indian Ministry of Environment, Forest and Climate Change's Standard Guidelines for Single-Use Plastics (2019) include examples of legal and policy options for prohibiting single-use plastics and case studies where they were successfully implemented. However, the guidelines do not offer options for multilayered packaging (MLP), as it notes that no adequate replacement technology exists (Chandran 2021). As MLP is one of the most common packaging types among top convenience items in Mumbai and is also among the most abundant litter items, the city may want to explore targeted ways of addressing MLP waste. The guidelines also explicitly mention the need for increased public education and outreach by local governments, which is an avenue that Mumbai could explore.

Nearly all plastic to-go product alternatives documented during the CAP surveys of stores and food vendors were available to customers at no additional cost to the consumer. Only one food vendor charged customers for paper plate alternatives at 5 Rs. Among businesses in Surat, food vendors and restaurants may have the greatest opportunity in terms of transitioning to alternative product types. For example, the CAP surveys documented plastic plates and cups replaced with paper and food stands using newspaper or foil instead of plastic wrappers. Similarly, wooden utensils and foil containers can replace common plastic items that are difficult to recycle. Wherever possible, reusable containers and utensils should be encouraged and, ideally incentivized, as reuse is preferable to any single use material. However, the prevalence of single use plastic bags surveyed and limited alternatives for consumers in Surat illuminates an opportunity for the city to encourage vendor buy-in for phasing out certain single use items and integrating availability of alternative options, ideally with little to no additional cost for consumers. In order to sustain their high performance and ranking under Swachh Surveskshan, the city could leverage Information, Education, and Communication (IEC) as a way to encourage vendor buy-in and participation through targeted campaigns to reduce litter and encourage alternatives to single-use items. As the implementation of relevant rules and regulations continue in Surat, there could be opportunities for learning among companies and similar cities that have successfully transitioned away from single use plastics in a way that is cost effective.

Figure 13: Example of single-use plastic bag used for FMCG items in Mumbai

(Photo Credit: CEE)

Nearly all to-go product plastic alternatives documented during the CAP surveys of stores and food vendors were available to customers at no additional cost. The exceptions were for paper straw products, where the cost was added in Maximum Retail Price (MRP) at three small grocery shops. This demonstrates buy-in from vendors to phase out certain single-use items and the availability of alternative options, ideally with little to no additional cost for consumers. As the implementation of relevant rules and regulations continues in Mumbai, there could be opportunities for learning among companies and similar cities that have successfully transitioned away from single-use plastics in a way that is cost effective.

Policies banning consumption of plastic products

India has recognized the urgent need to tackle the environmental and health impacts of plastic waste. In 2014, the Indian government launched the Swachh Bharat Abhiyan (Clean India Mission), a nationwide campaign to clean up the country and promote effective waste management practices. One of the key objectives of this campaign was to eliminate single-use plastic by 2022. To achieve this, the government implemented bans on specific types of single-use plastic items and is actively promoting practices that aim for the complete collection and recycling of plastic waste by 2025. However, it is worth noting that bans on some items were lifted or augmented to include compostables, and implementation is still under development (Mukhopadhyay, 2022). Following suit, the Municipal Corporation of Greater Mumbai (MCGM) implemented a ban on single-use plastics in June 2018 to address the growing plastic pollution problem. This ban encompasses a wide range of plastic products (see Introduction for full list) and encourages the use of eco-friendly alternatives. However, the restrictions were announced just three months before they were to take effect leaving very little time for adjustments. For some, the government relaxed the rules, exempting small traders and granting more time for large companies to come up with solutions for retail packaging, including alternative materials and recycling schemes.

Product bans and incentive programs can be effective regulatory measures for reducing plastic consumption, reducing waste generation and management pressure, and reducing leakage into the environment (Maes et al. 2018, Schuyler et al. 2018). There are several policies in place regarding the use and disposal of solid waste and specifically plastic in India, including the Plastic Waste Management (PWM) Rules of 2016 and sequential amendments in 2018 and the Solid Waste Management Rules, 2016. These policies are advised by the Ministry of Environment, Forest and Climate Change, the National Plastic Waste Management Task Force, and the Committee on Urban Solid Waste Management in India (Aiyavoo 2018). Nationally, the PWM Rules and respective amendments have targeted prohibitive measures to tackle challenges with plastic waste management. Specifically, there have been wide-reaching bans on plastic products, with urban local bodies (ULBs) enforcing them (Karasik et al. 2020). One of the country's first targeted bans was on plastic microbeads, which can be used in cosmetic and household products like detergent (UNEP 2018). Additionally, some of the country's early bans targeted plastic bags specifically, with the Plastic Waste (Management & Handling) Rules of 2011, prohibiting retailers from distributing plastic bags to customers for free. Later, in 2016, the Plastic Waste Management Rules resulted in several stipulations restricting the use of plastic bags. The rules specified that non-compostable plastic bags must be more than 50 microns thick to improve their recyclability, required the phasing out of the manufacturing of non-recyclable plastic bags over two years, created a standardized marking and labeling system for bags, and made retailers liable to penalties for providing customers plastic bags that failed to meet standard requirements. Also, as per Plastic Waste Management Amendment Rules 2021, specific categories of single-use plastic items have been banned across India since July 01, 2022.

Collection

Overview of Mumbai's Waste Generation

Collecting Mumbai's daily generated waste poses significant challenges due to its dense population and diverse

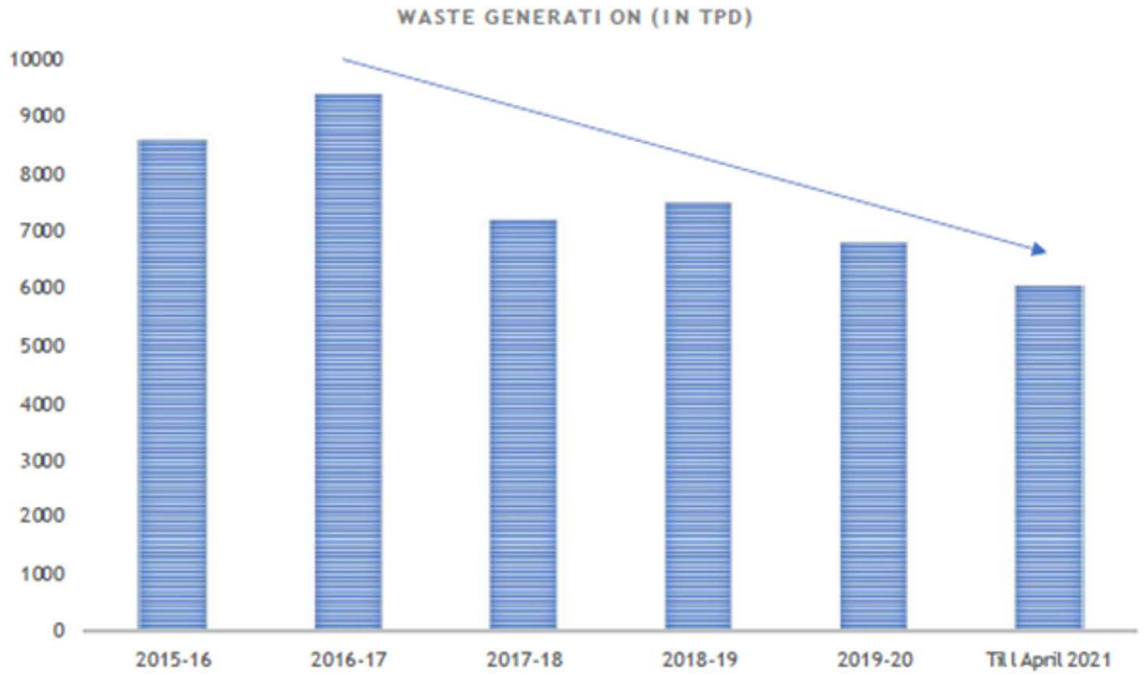
urban landscape. This section provides an overview of waste generation patterns in the city, highlighting the efforts and challenges in managing this complex issue.

Mumbai waste generation ranges from 0.45 to 0.85 kg per capita per day (A. Kumar & Agrawal, 2020), marginally higher than the national average of 0.57 kg per capita per day (Kaza et al., 2018). However, these figures may underestimate the actual waste generated, especially considering the presence of informal settlements contributing additional unaccounted waste.

According to the Central Pollution Control Board (CPCB), Mumbai generated approximately 11,000 metric tons of waste daily in 2015-2016 (CPCB, 2016). Subsequent insights provided by the BMC reported a range of 6,500-6,800 metric tons of daily waste generation in 2019-2020, which declined to about 6,000 metric tons in 2020-2021 (BMC, 2021). Notably, these latter figures exclude waste generated by bulk generators, such as residential, commercial, and institutional buildings, which were mandated to treat organic waste on-site. In 2020, with around 6,800 metric tons of waste collected, transportation necessitated 1,676 daily trips. By 2021, with reduced waste generation due to the exclusion of bulk waste generators, the number of trips decreased, but was still over 900 (BMC, 2021). Moreover, an estimated 800 tons of construction and demolition (C&D) waste is collected daily (MCGM, 2022), posing a logistical challenge.

Despite efforts, including the SWM Rules of 2016, Mumbai continues to grapple with the challenge of managing substantial waste volumes (Figure 14). Addressing these issues requires efficient transportation systems and innovative waste management practices, particularly in light of urban expansion and proliferation of informal settlements.

Figure 14: Waste generation since implementing the rule that bulk-generators treat their waste onsite



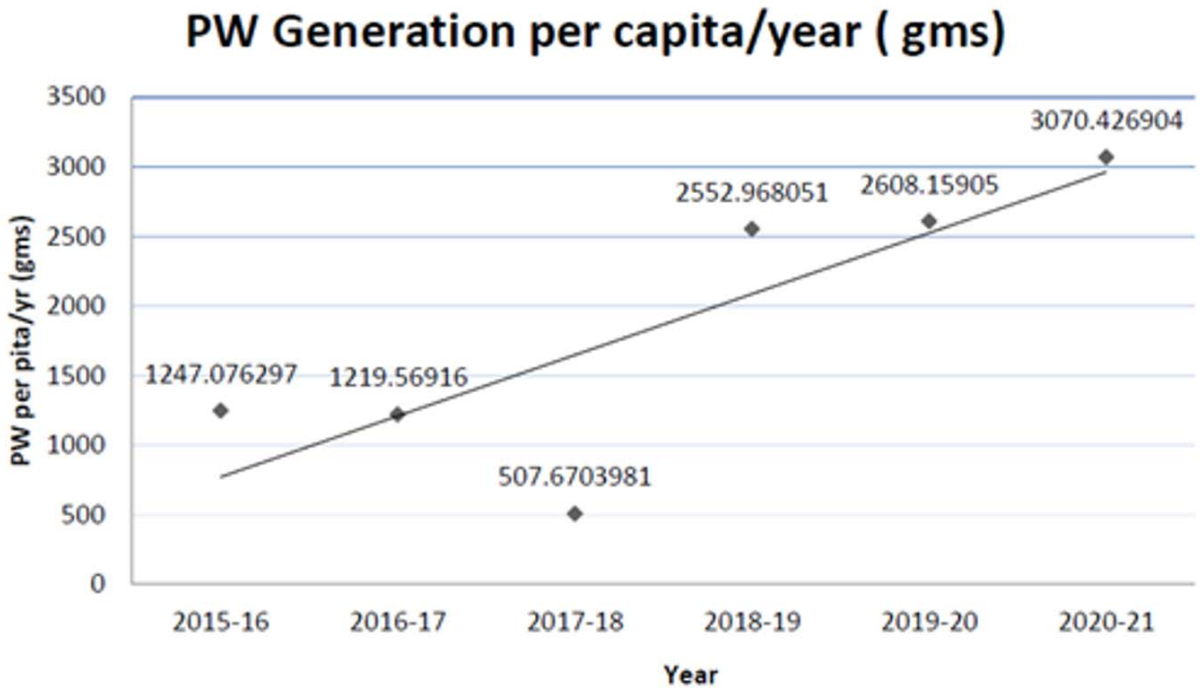
Sources: (MCGM, 2022) https://www.mcgm.gov.in/irj/portal/anonymous/qlenvornmetn

Waste Composition

In 2017, Indian cities exhibited a typical waste composition, with approximately 41% organic, 40% inorganic, and 19% potentially recyclable materials (Kumar et al., 2017). Mumbai follows this trend, with a notable proportion of organic wet waste (73%), followed by organic dry waste (21%) and potentially recyclable materials (6%) (BMC, 2021; MCGM, 2022). These portions highlight the critical role of source segregation in maximizing disposal efficiency and resource recovery.

Maharashtra, the state Mumbai is located in, ranks among India's top three states in both population and plastic waste generation. Plastic waste is a significant component of Mumbai's waste stream, with Maharashtra contributing 12% of the nation's plastic waste and an overall per capita plastic generation rate of 10 grams per day (CSE, 2020). Over the past six years (2016-2021), there has been a nearly twofold increase in per capita plastic waste generation across India (Figure 15).

Figure 15: Year wise Trend in Per capita Plastic Waste Generation trend



(CPCB, 2021)

Municipal Waste Collection Infrastructure

The BMC functions as the primary entity responsible for waste collection and transportation within the city. Mumbai, with its 24 administrative wards, features a waste management system comprising designated waste collection centers and administration mechanisms. However, the dynamic urban landscape with its rapid growth has resulted in inconsistencies in waste collection, resulting in localized overflow issues.

To address these challenges, BMC has enlisted the support of a private agency for the collection and transportation of solid waste. All wards have dedicated vehicles equipped with route maps and scheduled work shifts, with each vehicle making multiple trips per day, to ensure the systematic collection of solid waste from households.

Given the diverse geological and geopolitical conditions across wards, each area presents different characteristics and norms necessitating tailored collection systems. For instance, areas characterized by high transient populations (such as Ward A), generate distinct forms of waste, which poses additional challenges to waste management initiatives. Single-use plastics, cigarette butts, and snack wrappers are common items seen along roadsides in these areas, prompting the implementation of manual and mechanical road sweeping operations. Sweeping activities in collaboration with NGOs are conducted in three shifts throughout the day, aligning with the specific requirements of each ward.

Door to door collection presents multifaceted challenges. Stakeholders cited constraints such as limited manpower, divergent working hours, and malpractices of waste disposal. Additionally, the city operates 46 dry waste collection centers (DWC) managed by 38 different organizations, with some organizations running multiple centers (e.g., Stree Mukti Sanghatana (6 centers), Akar (5 centers), and UNDP (3 centers)) These DWCs play a pivotal role in waste management and recycling, receiving significant volumes of dry waste annually, including plastic for segregation and recycling. In 2022, the DWCs received approximately 52,295 metric tons of dry waste in 2022, with 12,777 metric tons of plastic segregated and sent for recycling. For instance, the Kurla Scrap Yard (Mankhurd, Mumbai) discussed later, is an example of informal entrepreneurs contributing to waste segregation efforts and thus enhancing the effectiveness of DWC operations.

However, infrastructure inadequacies within dry waste collection centers pose challenges to their operational efficiency. While the BMC oversees approximately 46 DWCs, only a limited number possess adequate facilities, with the majority facing deficiencies in waste availability, restroom facilities, sorting areas, storage spaces, and security protocols.

The waste management landscape across Mumbai demands a comprehensive approach to address the intricate challenges inherent to the city. Effective collaboration between public and private entities, alongside strategic infrastructure development may play a pivotal role to ensure full-coverage waste collection within the city.

Waste Collection and Transportation

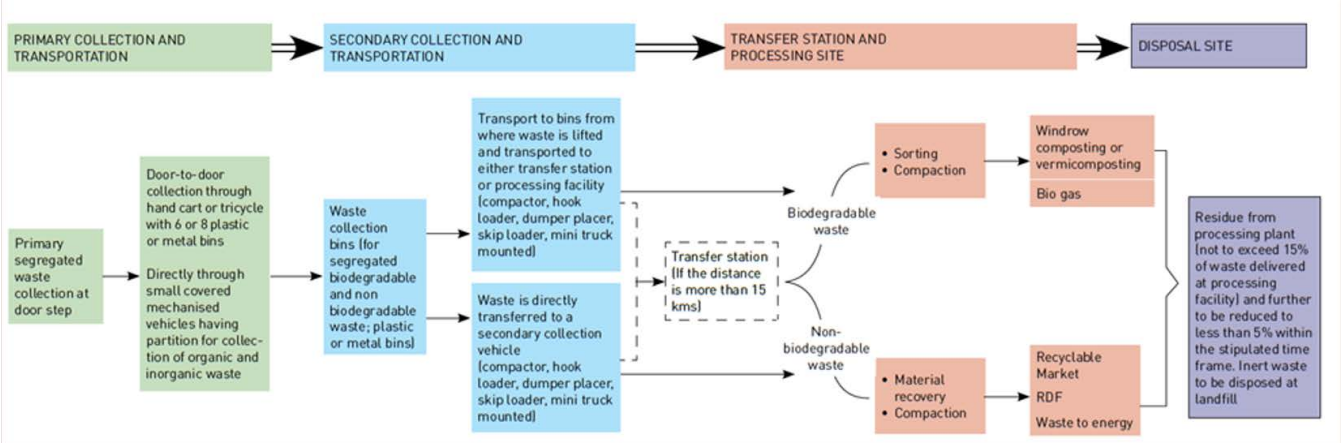
Mumbai faces substantial impediments in efficiently managing its daily waste output, attributed to the city's congested and narrow streets. Moreover, waste collection endeavors predominantly rely on techniques fraught with challenges given the intricacies of navigation in the urban environment.

According to the city's reports, Mumbai has 2,110 1.1 cubic meter containers and 949 community collection points. An array of vehicles, including compactors, skip vehicles, refuse vehicles, bulk refuse carriers, jeeps, JCB machines, and stationary compactors, are deployed to facilitate the collection and transport of municipal solid waste.

BMC has established 46 dry waste collection sorting centers dispersed across the city's 24 wards, complemented

with a fleet of 96 vehicles tasked with bringing dry waste to these centers. Dry waste undergoes meticulous manual segregation into distinct categories, encompassing paper, cardboard, thermocol, plastic, metal, and glass before being channeled into informal recycling processing facilities. Plastic waste undergoes further segregation and is subsequently dispatched to recyclers, often operating within the informal sector (Figure 16). Additionally, under Extended Producer Responsibility (EPR), corporations like Bisleri and Coca-Cola have established plastic processing units nationwide.

Figure 16: Generic flow chart of India household waste collection, transportation, and disposal system



Source: https://mohua.gov.in/upload/uploadfiles/files/Part.pdf

Role and Perspective of the Informal Sector

At present, Kurla Scrap Yard (Mankhurd) hosts around 250 establishments (i.e., *gallas*), according to stakeholder interviewees from the sector. Among these, approximately 10-12 are directly engaged in the systematic sorting of dry waste sourced from commercial entities such as hotels and office complexes. These entrepreneurs typically procure at a rate of Rs 2/- per kilogram), subsequently sorting the recyclable materials before vending them to high-value material aggregators.

There are numerous informal setups across Mumbai, such as Kurla Scrap Yard, that play vital roles in providing livelihood opportunities for informal laborers. Simultaneously, they contribute to bolstering the waste management efforts of the BMC by:

1. Indirectly aiding in the fulfillment of recycling objectives and the Swachh Survekshan Targets
2. Alleviating the strain on existing SWM infrastructure by segregating a considerable volume of recyclable waste on a daily basis
3. Reducing the burden on transportation systems and associated SWM department costs
4. Curtailing environmental and aquatic pollution by preventing waste leakage into surrounding environment

Informal dry waste segregation is categorized as a business-to-business model. This classification offers an opportunity to integrate this work into the Swachh Survekshan as a national level initiative focused on improving waste man-

agement and sanitation practices within urban and rural areas, and ensuring regulatory compliance by incorporating the informal sector into the SWM system. For instance, an informal waste collector interviewee coordinates the collection of dry waste from 20 to 25 different locations. Each trip yields approximately 2,700, resulting in a regular collection of 7 to 8 tons of mixed dry waste. With the support of a team of 20 individuals, this recycler can segregate 90% of the waste into roughly 20 material categories. Workers are remunerated with daily wages of Rs. 400 for women and Rs. 500 for men while ensuring the provision of monthly rent for the shaded area used during sorting operations.

Figure 17: Pictures of Informal Waste Collection Systems (waste bins, informal waste collection and segregation, etc.) in Mumbai

(Photo Credit: CEE)

Low Value Plastic and EPR

As per the EPR guidelines, systematic collection and disposal of single use plastic is required and waste picker organizations have been involved in collection of all kinds of plastic. Given the low-value of flexible plastics and the limited recyclability of single-use plastics, there is a compelling argument for the elimination and significant reduction of these plastic types.

Waste pickers primarily collect readily available materials with a high market value that can be sold at scrap shops, constituting their main source of income. Under EPR schemes, waste pickers receive nominal compensation, typically Rs.1 or Rs. 2 per kilogram of MLP. Collecting MLP at this rate poses significant challenges for the waste pickers, requiring labor-intensive efforts, often along roadsides. Collecting 1 kilogram of MLP entails approximately 1,000 bends, making it time consuming to other materials. Unless they receive remuneration commensurate with their efforts, it is financially unsustainable for waste pickers to collect MLP, especially considering the higher value attributed to most hard plastics. The chart below gives an overview of the rates of various materials collected at dry waste collection centers (per kg) (Figure 18).

Figure 18: Rate chart of plastic and baled plastic at DWC

(Photo Credit: CEE)

Waste picker organizations have also emphasized that the BMC should be responsible in educating the public and enhancing current waste management practices. For instance, members of Stri Mukti Sanghatana (an environmental non-profit in Mumbai) continuously advocate for waste segregation within the community to facilitate smoother transportation and disposal processes. However, proper segregation practices are not consistently implemented. It may be helpful to promote segregation practices with BMC support to ensure widespread community awareness.

Furthermore, organizations operating material recovery facilities (MRF) centers under BMC jurisdiction are concerned about facility sanitation, hygiene standards, and improved working conditions for laborers. Inadequate workplace conditions and limited infrastructure present significant challenges in achieving the broader goals of initiatives like Swachh Survekshan.

Challenges and Opportunities in Waste Collection

In light of the complexities surrounding waste management efforts and the concerns raised by waste picker organizations, it's evident that addressing waste collection challenges is crucial. Interviewees detailed how these challenges are not just about economics and environmental impact, but also encompass broader issues of logistics, infrastructure, and human rights.

Cost

One interviewee mentioned cost as a barrier for a self-funded organization:

> **"Yesterday, they told me that they will charge us 20 rupees per kilogram for collecting those plastic bins. They said they would provide us with the documents, but it's not feasible for us to pay 20 rupees per kilogram. We are already self-funding, and every time we have to pay."**
>
> **— NGO Representative**

Waste Segregation

A critical concern in Mumbai's waste management system lies in its waste segregation infrastructure. Despite individual efforts at attempting segregation, the majority of generated waste remains unsegregated, obstructing recycling and processing endeavors. This problem is exacerbated by the subsequent mixing of segregated waste during collection, impeding effective segregation efforts. Interviewees expressed disappointment when they witnessed their segregation efforts being disregarded, leading to a sense of disillusionment and discouragement to continued waste segregation at home.

> **"In the past, we have had…just private players coming in and taking waste, often it gets dumped in the mangroves or in areas like the Bundra Kurla Complex. We have heard of instances like that, unfortunately."**
>
> **— Private Waste Management Representative**

> **"So, she wondered where this waste was going. She followed the truck, and it led her to the dumping ground."**
>
> **— Private Industry Representative**

Manual sorting, the predominant method employed, proves to be labor-intensive, time-consuming, and inefficient, particularly when handling large volumes of mixed waste (Figure 19). Economically, a significant portion (80-85%) of the total Municipal Solid Waste (MSW) management budget is allocated to waste collection and transportation (Sharholy et al., 2008). Efficient fund allocation mandates accurate cost estimation within waste management planning. Systematically analyzing the economic and environmental aspects can aid in informed decision-making to streamline waste management systems. Such comprehensive analyses are instrumental in optimizing resource allocation and devising strategies that strike a balance between economic efficiency with environmental sustainability.

Figure 19: Waste sorting facilities in Mumbai

(Photo Credit: CEE)

Many interviewees felt that non-adherence to waste segregation hinders the effectiveness of current waste management efforts:

> **"Yes, there is a problem, but what I've observed in Mumbai, compared to Pune, is that source segregation is not emphasized as much. Municipal corporations do not enforce it strongly."**
>
> **— Private Waste Company Representative**

> **"Yes, a lot of my students keep saying the same thing, 'if we separate the waste, the housekeeping staff still mixes it, so what's the benefit?'"**
>
> **— Private Waste Company Representative**

> **"There are contractors as well, who are associated with BMC (MCGM). Their monetary aspects are managed separately. That means now the BMC (MCGM) trucks come and impose penalties for the waste, and now we have noticed that they just go to the outskirts and throw away the garbage. And towards our society, which is a big society, they still don't ask us to segregate. Even though we speak up, they don't enforce segregation. They charge us so much, and we provide them with unsegregated waste. It means they don't care. They just want to dump and dispose of all the garbage without any segregation."**
>
> **— Private Waste Company Representative**

> **"Regarding waste pickers, they're constant; we see them daily. You [may be] guilty of not segregating wastes properly. Here the contracts change frequently; sometimes you are strictly asked to segregate based on society's pressure, which means that the problem is that we are still restricted with two-way segregation streams - wet and dry waste. What about the third, which contains your pads, diapers, condoms, and other things? These things are still sent with**

> **the dry waste and still people put their hands into them and touch them. So, the segregation at three levels is still very poorly enforced in Mumbai and the reasons are plenty."**
>
> **— NGO Representative**

> **"According to the solid waste management rules, for events over 100 people, they do have a mandated waste segregation that needs to happen at events. But, again, unfortunately, we are not aware of the on-ground realities whether it actually happens at the events that we don't work at. And, quite often it's not really the rules that motivates people to approach us, nobody really looks at us."**
>
> **— Private Waste Management Representative**

> **"One, there are a lot of collection rules and a collection setup is in process. I think those are quite okay, but if you look at it at the end of the day, they will receive a lot of mixed waste. So, while there is a lot of awareness and a mandate for segregation, it doesn't get implemented. So, it's a lack of enforcement. That's something I can say that's definitely missing."**
>
> **— Private Waste Management Representative**

One interviewee mentioned how household waste segregation efforts negatively impacts informal sector workers' ability to find recyclables:

> **"The municipality is not strict and the women think that when the waste is segregated, everyone claims the waste. That is, the municipal workers, sweepers, even the [domestic help] in the house take away milk bags. In other words, the [the informal waste collectors] don't get anything [because the household segregated waste is taken and sold by others], so segregation has become a hindrance to the work of waste pickers. Because there is no door-to-door collection promise."**
>
> **— Informal Waste Representative**

Sanitation Workers' Rights

Interviewees shared their concerns about the pay and working conditions of informal sector workers. Some interviewees mentioned a lack of safety gear as an issue:

> **"No one gives [waste pickers] safety gear. How will the organization provide it? They are the ones who should spend the money. Safety gear is expensive. And you have to change [safety gear] all the time."**
>
> **— Informal Waste Representative**

> **"When I went to work on dumping for the first time...there was no security of any kind. There are no shoes on their hands, no shoes on their feet, and there's no protection of any kind. You work among them, and on the other side, there's a so-called employee who has all the facilities from MCGM, and here, you're working for free, and we witness what happens. When they work, they get sick, they have tuberculosis, they have lung problems... After [work], they indulge in intoxication, and how are we supposed to cope with dehydration at the station?"**
>
> **— Informal Waste Representative**

Other interviewees believed the informal sector is not fairly compensated for their labor:

> **" ...When [the government] goes to court, their first defense is that these workers are not employees; they are voluntary workers. We don't pay them a salary; we provide them with an honorarium. There is no applicable law for them because there are 18 workers under one contractor, and there are around six thousand such workers. But none of them are covered by any law."**
>
> **— Informal Waste Representative**

> **"They were supposed to be paid 300 rupees per day as a bonus during COVID. Until today, not a single laborer from Katradi has received that bonus... Now, the government makes announcements, but it's all just on paper."**
>
> **— Informal Waste Representative**

> **"And the work performed is of a perennial nature. It is a continuous and consistent job. The contract laborers must be given a sufficient rate for their work if they are performing a statutory duty. Then you cannot give them a contract."**
>
> **— Informal Waste Representative**

> **"You are putting all the burden on the poor. You either give them at least the same wage or give them the same wage as the women's liberation organizations have obtained - this [is an] exploitative structure."**
>
> **— Informal Waste Representative**

Other interviewees noted how difficult working conditions in the informal sector tend to be:

> **"After working so hard for twelve hours, they are paid just Rs. 90. During these twelve hours, the laborers don't get any proper rest or breaks. They cannot go to eat at hotels, take a bus, or a rickshaw. Even for drinking water, they have to pay Rs. 5 to someone who sells water there. And this water they buy in an old oil container; they have to wash their hands with it and drink**

> **water from it. They eat sitting on heaps of garbage or a nearby rock. This is how their lives have been."**
>
> **— Informal Waste Representative**

> **"All those slogans about making Mumbai beautiful, clean, and green were just for show. No one cares about laborers and how they will wash their own hands and feet; they don't drink water, and in such situations, they are expected to work. The contractor doesn't even realize what's happening."**
>
> **— Informal Waste Representative**

One interviewee described how they believe the informal sector is unfairly maligned and blamed for various problems:

> **"What the municipality wrongly does is that when there are fires, they put the blame on the waste pickers. Actually, because methane is flammable, there will be fires, and the dumping ground there is also used as a toilet by the surrounding population. So, if the smoke from the fire is going there, if [the fire] is small, it will go to the residential area itself."**
>
> **— Informal Waste Representative**

One interviewee spoke about how the structure of EPR tends to prevent the informal sector from participation:

> **"They are wiping out the waste pickers. Because to do the EPR, as these companies do not have required skill sets, they appoint PROs [Producer Responsibility Organization] for this purpose. Now, to become a PRO, one needs certification and much more documentation that a waste picker organization may not have."**
>
> **— NGO Representative**

One interviewee mentioned how gender influences opportunities and income within the informal sector:

> **"While working at a [scrap shop], we realized that men get better opportunities and income, while women don't get such opportunities."**
>
> **— Informal Waste Representative**

Finally, one interviewee felt that the overall state of waste pickers' rights is slowly improving:

> **"But the municipality also considers us as the waste pickers. Now they have improved a little bit... They've started paying attention to us."**
>
> **— Informal Waste Representative**

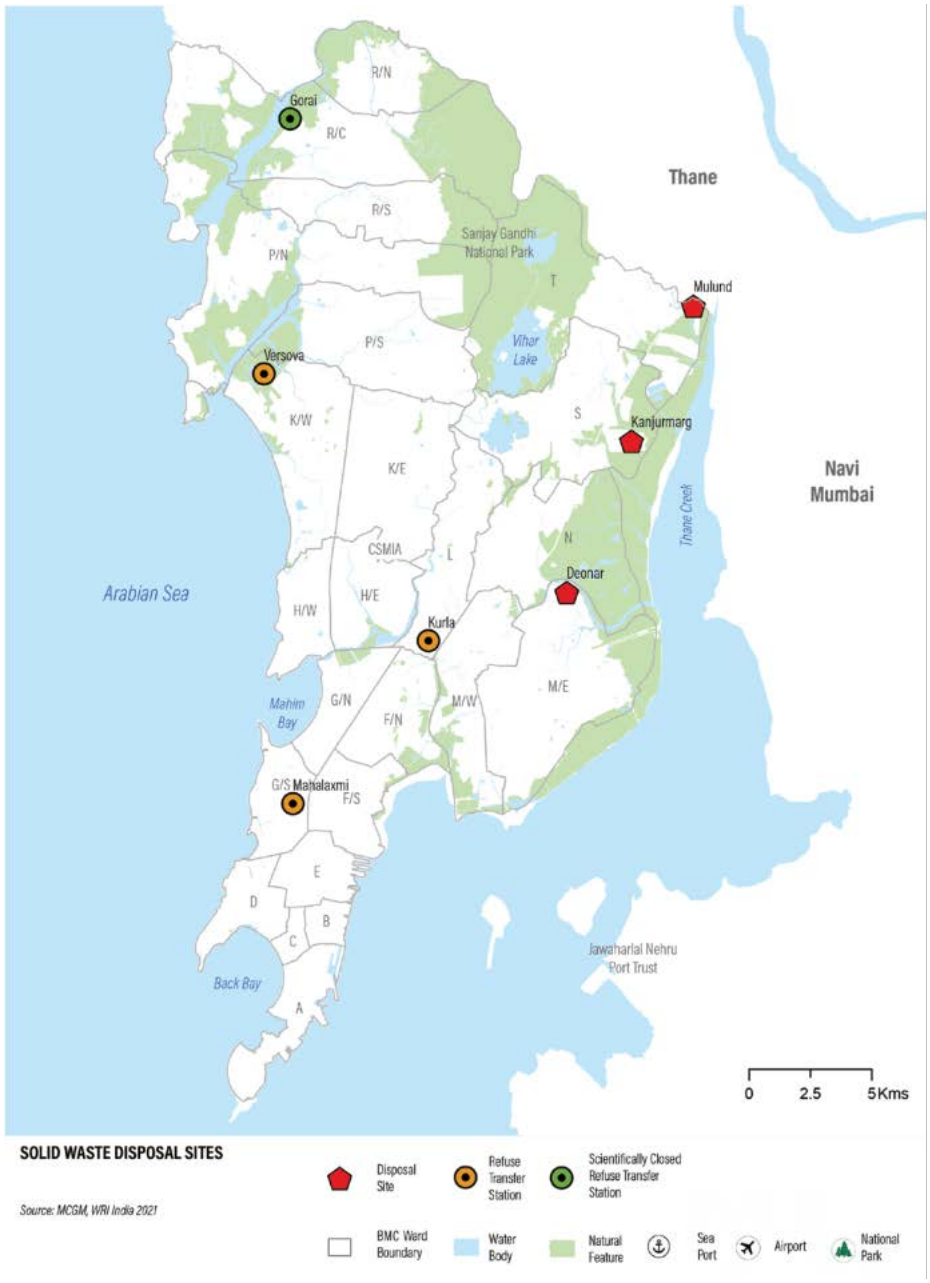
In conclusion, interviewees highlighted several interconnected factors contributing to challenges in waste collection including cost, waste segregation, and the informal sectors' rights and wellbeing. Waste segregation emerged as a significant logistical hurdle underscored by the disparity between public awareness of segregation practices and the actual infrastructure and capacity to implement them effectively. Moreover, sanitation workers' rights were a recurring concern, with interviewees expressing apprehension regarding waste pickers' access to personal protective equipment, their overall working conditions, and the absence of adequate legal safeguards. These insights highlight the multifaceted nature of waste management challenges and emphasize the need for comprehensive interventions that address logistical, infrastructural, and human rights aspects of waste collection.

End of Cycle

Existing Waste Treatment Facilities

The current management of MSW in Mumbai is facing a critical phase due to limited suitable facilities to treat and dispose of the considerable amount of waste generated daily. Non-engineered disposal impacts the environment and human health. Without organized management systems, MSW often ends up in low-lying areas without any precautions or operational controls, making it a prominent environmental problem in megacities like Mumbai (Dutta and Jinsart, 2020). The management of MSW requires proper infrastructure, maintenance, and upgrades for all activities. This becomes increasingly expensive and complex due to the continuous and unplanned growth of urban centers.

Figure 20: Solid Waste Disposal Sites and Transfer Stations, Mumbai Climate Action Plan 2022



Source: https://drive.google.com/file/d/1iVW7jjdho0mEW2-4nj9jtw0laiP9EsvW/view

Mumbai operates three primary waste processing facilities—Deonar, Mulund, and Kanjurmarg (Figure 20, Table 6). However, these facilities fall short of meeting the city's demands, with only 20% of the total waste collected undergoing proper processing (Joshi et al., 2016). The remaining 80% is inadequately treated (S. Kumar et al., 2009; Sharma & Chandel, 2017), leading to improper disposal practices such as uncontrolled dumpsites and burning. Inadequate treatment, especially at Deonar, which faces recurrent large-scale burning incidents, lead to significant environmental and health hazards.

In Mumbai, the challenge of managing solid waste at the end-of-life stage is profound, given the daily generation of

around 9,000 - 11,000 metric tons, translating to a per capita waste generation between 0.45 to 0.55 kg per day (Annepu, 2014; GCF, 2018; Sharma & Chandel, 2017). Insufficient waste collection and treatment methods result in over 50% of waste being openly dumped and less than 20% being adequately treated. If current practices persist, this scale of waste will demand approximately 1,450 km2 of land for systematic disposal through landfills, highlighting the urgency for sustainable waste management solutions (Joshi et al., 2016).

Table 6: Disposal Facility Area and Number of Years in Operation

Disposal Site	Area (Ha) Filling m	No. of Years Operating	Metric Tons per Day
Deonar	120 - 132	88	Approx. 1200 – 1700
Mulund	24	47	Closed
Kanjurmarg	65.96	4	Approx. 4500 - 5500

Source: Solid Waste Management Department (BMC, 2021)

The waste processing sites, notably Kanjurmarg, employ advanced bio-reactor technology and windrow composting methodologies (CPCB, 2016; Sharma & Chandel, 2021). Despite these efforts, the processing capacity at these facilities is insufficient to handle the substantial volume of waste generated, resulting in inadequate treatment and heavy reliance on open landfilling. Specifically, the Deonar dumping ground, one of Asia's largest and oldest landfills covering an area approximately 132 hectares (Table 6), has exceeded its capacity to accommodate additional waste (BMC, 2021).

The Deonar dumping ground has been a persistent concern due to recurring large-scale burning incidents, posing considerable risks to nearby communities and the environment. Figure 21 depicts a satellite scene of a fire event at Deonar in 2016. The emissions released during these fires contain harmful pollutants like particulate matter, volatile organic compounds, and toxic gasses. Prolonged exposure to these pollutants has the potential to induce respiratory issues, cardiovascular problems, and various health complications among the populace.

Figure 21: Satellite scene of Deonar Dumping Ground that caught fire on January 28, 2016

(NASA, 2016)

Anaerobic digestion could be a good option for further investment given Mumbai's high percentage of biodegradable (organic) waste and the city's high moisture content (MoHUA, 2021). A number of small-scale plants are running successfully in different cities in India. Mumbai has one facility at IIT Bombay Campus with a capacity to process 2 TPD and there is one owned by the Kalyan Dombivli Municipal Corporation that can process 10 TPD, which does not fall under BMC (Sharma & Chandel, 2017). Windrow composting is also recommended for treatment of organic waste (CPCB, 2016), and remains a recommended method for effectively treating organic waste.

Illegal Dumping

Indiscriminate discarding and illegal dumping of waste are common practices for those who do not participate in waste collection services and were frequently mentioned by interviewees (Figure 22). A majority of interviewees felt that one of the main challenges for waste disposal was illegal dumping, while one interviewee mentioned the location of waste incineration (or unorganized burning) as concerning. Dumping was frequently mentioned as a common waste disposal challenge, as shown below:

"How much space does one ton of wet waste require? We have that calculation. Because

we have been doing this for years. But the municipality has not done this calculation and has given less space. So, what do they do? Pay the municipality driver to send it back to the dumping ground."

— Informal Waste Representative

"If you look at Mumbai or the west, all the dumping grounds are coastal, which means you can directly smuggle from the dumping grounds by taking a boat and going to Dubai overnight."

— Academia Members

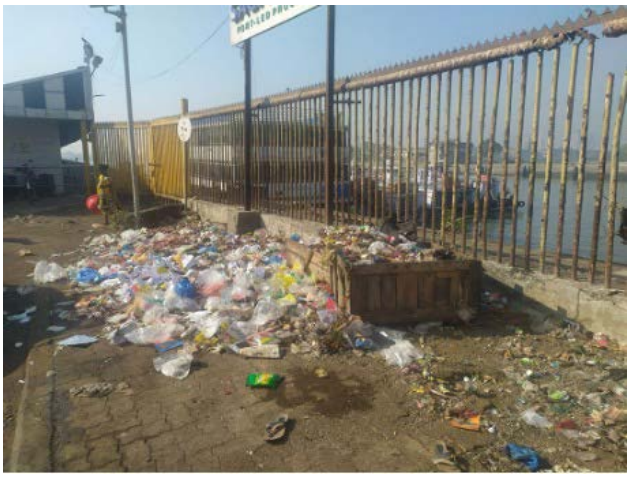
"It's a good plan to stop dumping. But still, some dumping is happening, and it's a huge task to manage such a large volume of waste."

— Informal Waste Representative

"If we have to take the waste to the dumping ground from ward A, they have to go to all the roads, there are many pits where people unofficially dump garbage...It's an unofficial practice, but everyone does it."

— Informal Waste Representative

Figure 22: Images of open dumping locations in Mumbai



(Photo Credit: CEE)

(Photo Credit: CEE)

Overall, addressing waste disposal challenges was a key point of discussion among interviewees, with a consensus on illegal dumping as a major challenge. Moreover, the location of waste incineration emerged as a concern among some interviewees, reflecting the widespread apprehension regarding the environmental and health impacts associated with inadequate waste treatment methods. Furthermore, initiatives involving private sector entities and non-governmental organizations (NGOs) in MSW management have emerged, indicating a trend towards collaborative efforts to address waste management challenges.

While Mumbai operates several waste processing facilities, including at Deonar, Mulund, and Kanjurmarg, these facilities struggle to meet the city's waste management needs adequately. Inadequate processing capacities, recurring burning incidents at landfills like Deonar, and challenges associated with illegal dumping demand urgent attention. Enhancing waste treatment infrastructure and adopting more efficient and sustainable waste management practices are imperative to mitigate the adverse health and environmental impacts caused by improper waste disposal methods in the city of Mumbai.

Existing Efforts & Initiatives

Thus far, the city has implemented several initiatives to improve waste management: Swachh Bharat Abhiyan, a plastic bag ban, zero waste initiatives for plastic reduction, some monitoring of plastic ban compliance, and an in-situ treatment mandate for bulk generators.

Swachh Bharat Abhiyan, launched in 2014, is a nationwide campaign aimed at achieving universal sanitation coverage and effective waste management practices. The City Government of Mumbai actively participates in this campaign by implementing a range of initiatives, such as the construction of public toilets, the promotion of waste segregation at source, and extensive awareness campaigns targeting citizens.

In response to the mounting plastic waste issue, the Maharashtra government implemented a comprehensive ban on single-use plastics in June 2018. This ban encompasses a wide range of plastic products and emphasizes the

adoption of eco-friendly alternatives. The City Government of Mumbai plays a pivotal role in enforcing the ban and ensuring compliance with regulations to curtail plastic waste generation.

To reduce the reliance on conventional waste disposal methods and promote sustainable waste management, the MCGM has initiated zero waste projects. These projects focus on enhancing waste processing capacity and facilitating composting. They also include outreach, education, and communication around household waste segregation and aims to provide segregated waste collection to households. These innovative approaches aim to minimize waste sent to landfills.

The Maharashtra Pollution Control Board oversees the enforcement of the plastic ban regulations, including the prohibition of plastic carry bags below 50 microns. The solid waste management department of the City Government of Mumbai has established designated collection and storage facilities to facilitate the proper disposal of banned plastic items. Furthermore, a toll-free telephone hotline has been instituted to provide citizens with information regarding the location of collection points for banned items. Media campaigns are also employed to raise awareness and foster public participation in reducing the usage of banned plastics. Since the ban's implementation, approximately 325 metric tons of plastic waste have been collected.

To enhance the efficiency of complaint resolution in solid waste management, the Swachhata App, developed by the Ministry of Housing and Urban Affairs, has been integrated with the 24/7 app of MCGM. This integration enables real-time reporting and monitoring of complaints, contributing to a resolution rate exceeding 99 percent in Mumbai. Regular monitoring ensures the effectiveness of complaint resolution efforts and allows for prompt action to address waste management concerns.

Despite the implementation of a two-bin segregation/collection system for wet organic and dry inorganic waste, waste segregation remains a challenge in Mumbai. The City Government of Mumbai conducts extensive awareness campaigns and educational programs through various mediums, including television commercials, billboards, and other platforms. These initiatives aim to educate citizens about the importance of waste segregation, responsible waste disposal practices, and the associated environmental benefits. Public participation and behavioral change are pivotal for the long-term success of waste management efforts.

The Municipal Corporation of Greater Mumbai has mandated in-situ treatment of solid waste for bulk generators (establishments that generate more than 100 kg of waste daily or have an area above 20,000 sq m). This mandate requires bulk generators to implement waste treatment facilities on their premises to address waste management at the source. This includes on-site source segregation, composting of wet waste, and collection of dry waste by authorized waste pickers or authorized dry waste recyclers (MCGM, 2017). By adhering to this practice, waste generation is reduced, and responsible waste management practices are promoted among large-scale waste generators. However, some reports have suggested that implementation and enforcement across the city has not been consistent, and there have been some difficulties particularly following the COVID-19 pandemic (Pinto, 2021).

Leakage

Overall Litter Count and Composition

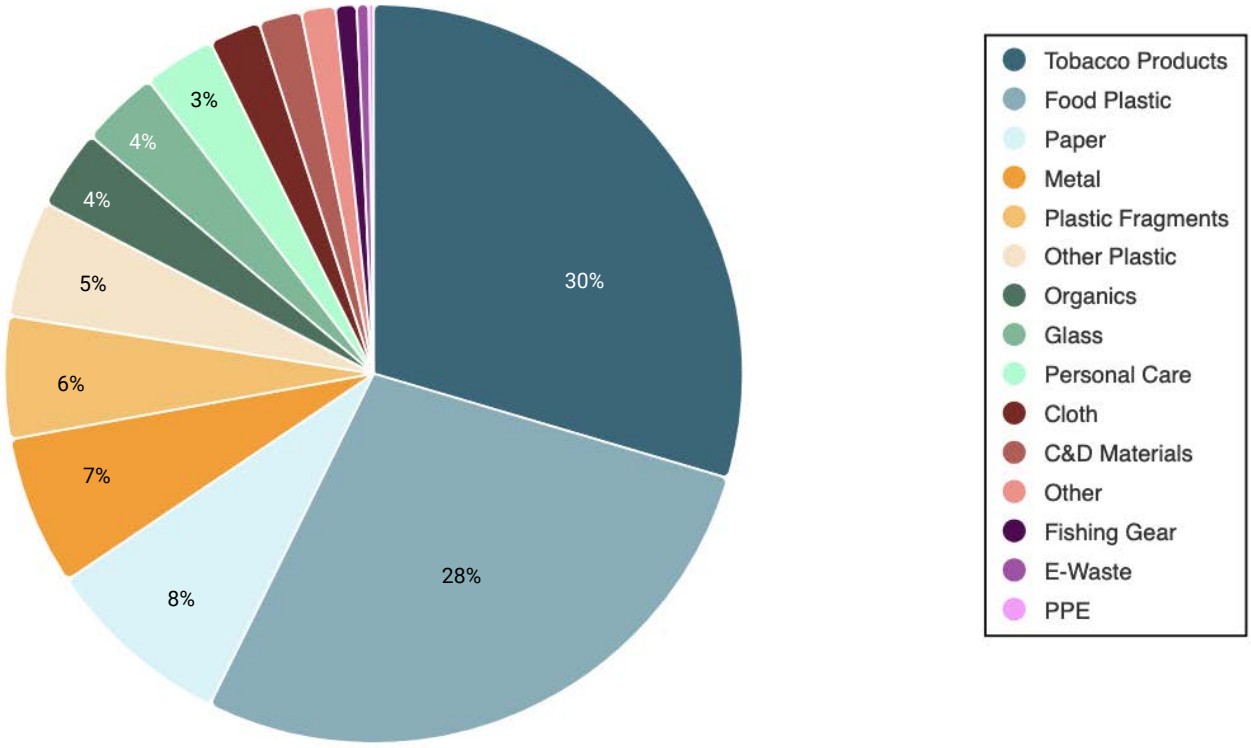
In total, 9,438 litter items were recorded across 27 100m2 transects in nine different square kilometer areas sampled between December 2022 and May 2023 (Figure 23). Litter transect locations were selected using a stratified random sampling method, in which transects were randomly selected in nine square 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 app.

Figure 23: Litter tracking in Mumbai

(Photo Credit: CEE)

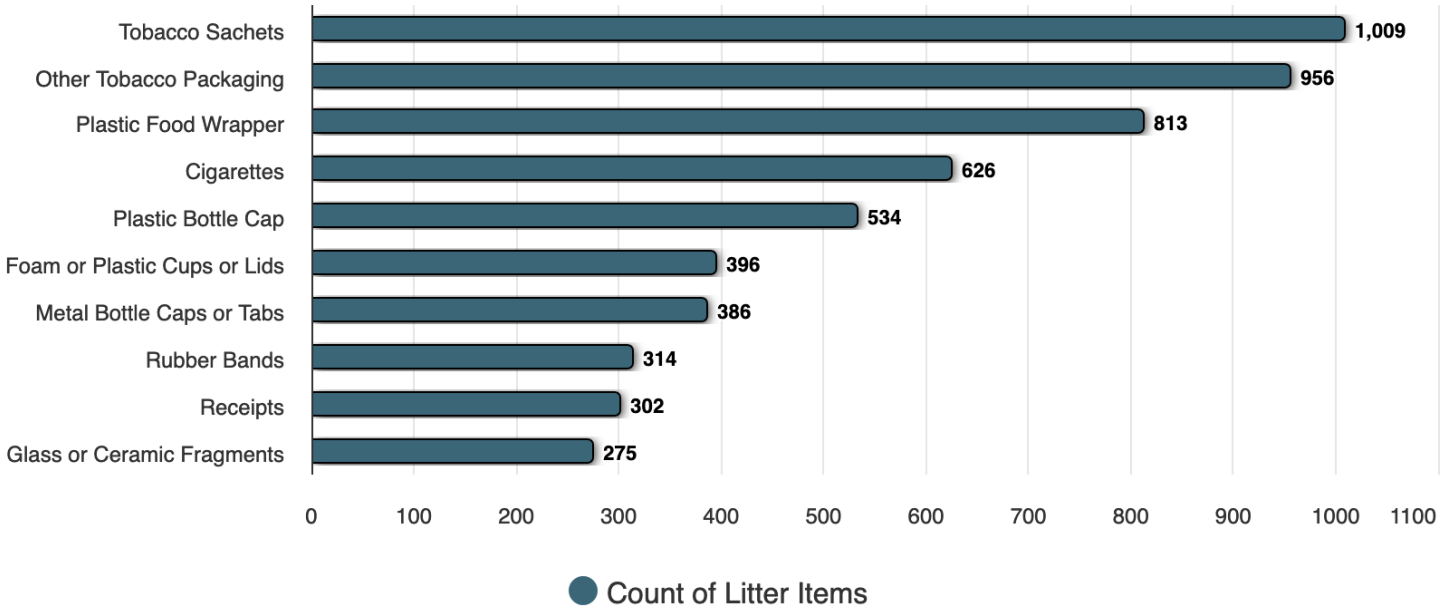
Over half of all litter items identified were either in the category of tobacco products (all of which contain some type of plastic) or food plastic (Figure 24). Interestingly, the third and fourth most common material type among litter items was not plastic, but was paper (8.2% of items) and metal (6.6% of items).

Figure 24: Material Breakdown of Litter Items



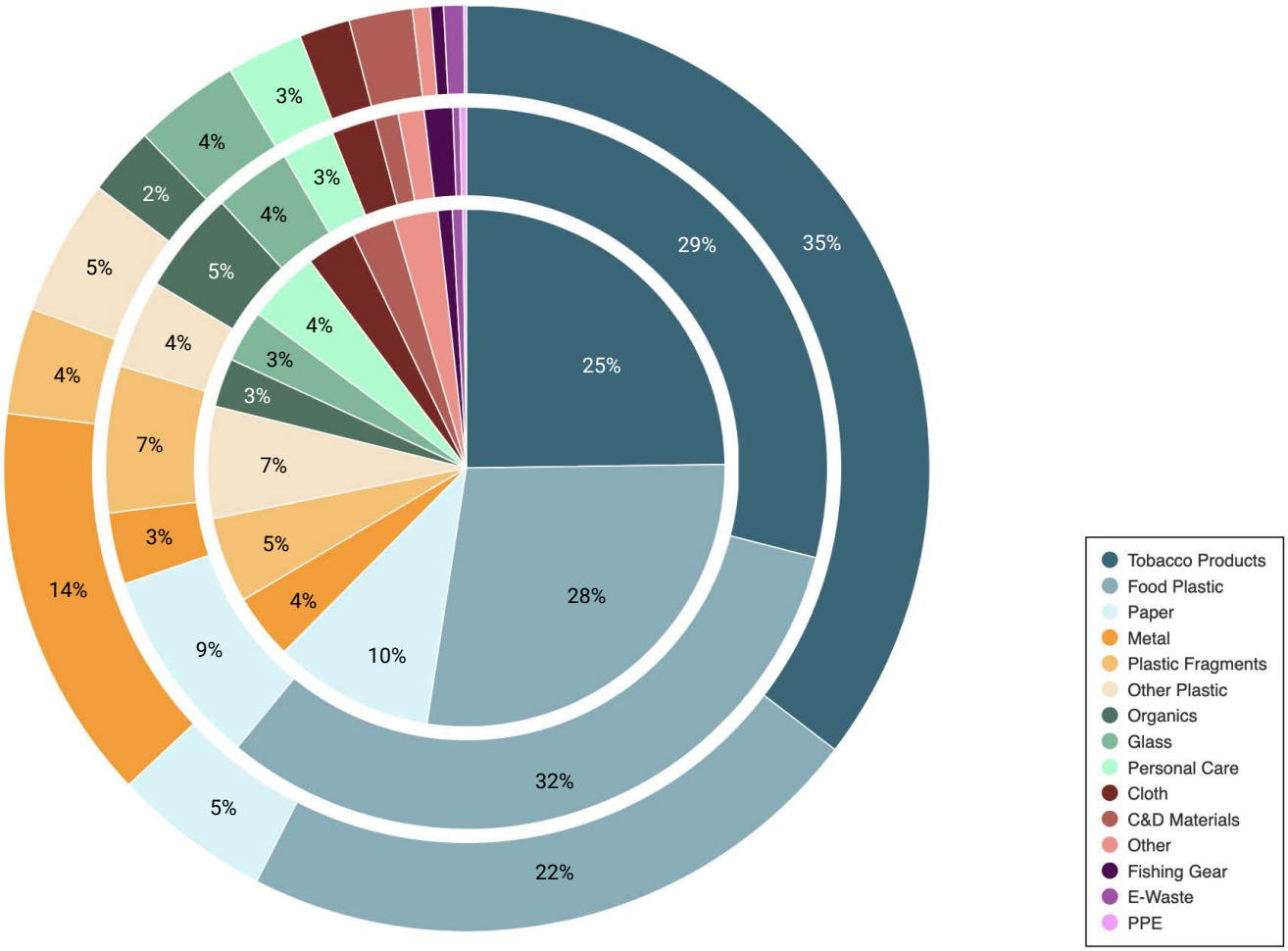
Tobacco products comprised three of the top five most common litter items, and included tobacco sachets (the top most common item), other tobacco packaging (the second most common item), and cigarettes (the fourth most common item) (Figure 25). Plastic food wrappers were the third most common litter item found. Other common plastic litter items included plastic bottle caps, foam or plastic cups or lids, rubber bands, and receipts. Metal (e.g., metal bottle caps or tabs) and glass (e.g., glass or ceramic fragments) were also among the top ten most common litter items in Mumbai.

Figure 25: Most Common Litter Items



Tobacco products and food plastic were ubiquitously the top most common material categories for litter products when observed across the three ambient population tertiles sampled, both comprising a combined >50% of all litter items in each tertile (Figure 26). Paper was the third most common litter item in lower and middle population tertiles, while metal was the third most common litter item in the high population tertile.

Figure 26: Proportion of most common material types among litter in lower (inner), middle (middle), and upper (outer) population count areas

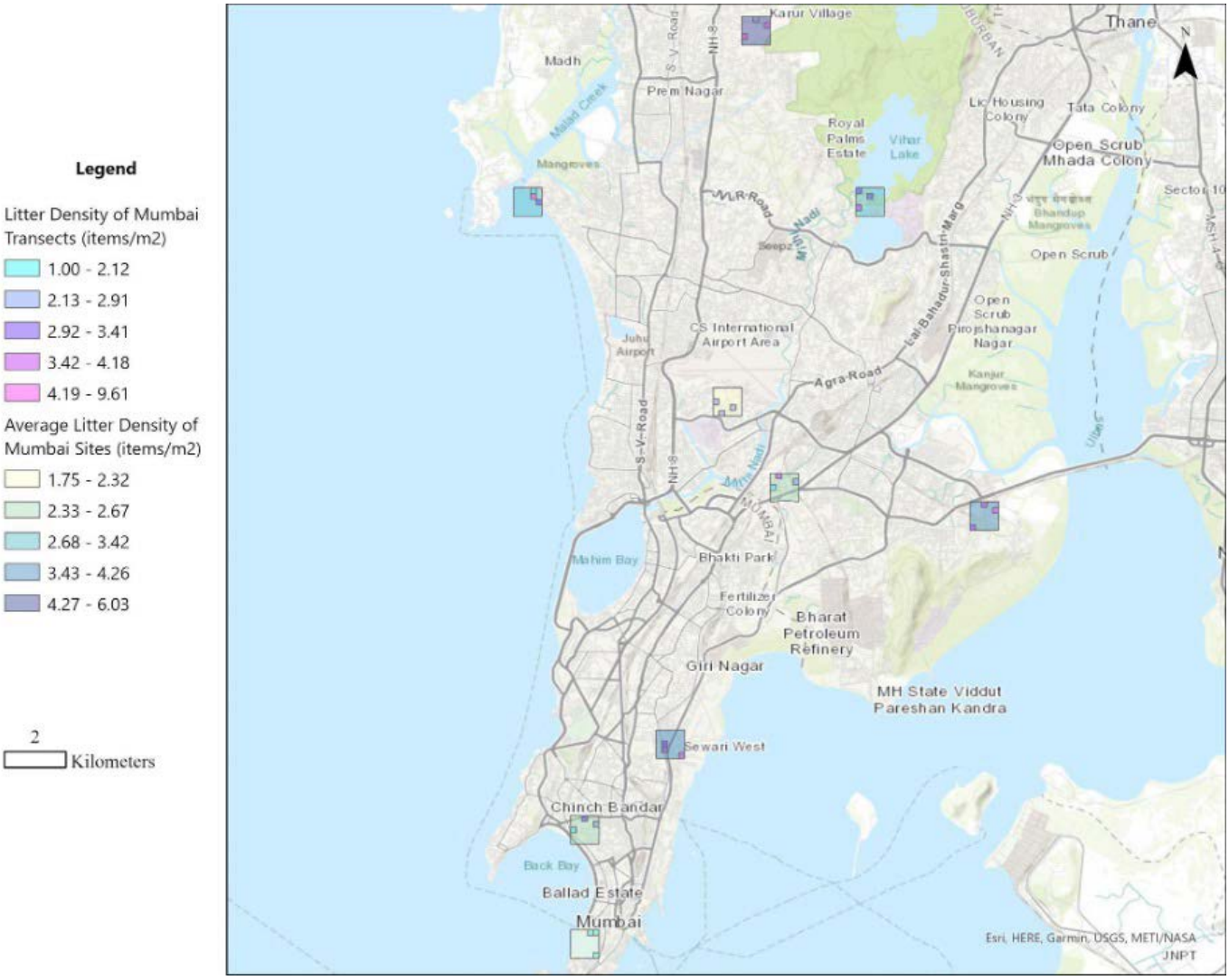


The middle population tertile group has the highest litter density according to population, followed by the high population and low population tertiles (Table 7, Figure 27). Tobacco sachets, plastic bottle caps, and cigarettes were among the top five most common litter items in each population tertile. Litter densities in general were slightly higher in Mumbai (~3.23 items/m) than averages observed in Surat (~2.81 items/m) and Chennai (~1.08 items/m), though similar to that observed in Pune (~3.21 items/m). Also similar to Pune, non-plastic items such as paper, metal, and organics comprised a large amount of the litter identified in Mumbai. As described in the waste collection section, street sweeping of litter occurs in three continuous shifts 24 hours a day.

Table 7: Litter Density and Top Litter Items from All Transects

Ambient Population Density	Top 5 Litter Items	Average Litter Density (items/m²)
High	1) Other Tobacco Packaging 2) Metal Bottle Caps or Tabs 3) Tobacco Sachets 4) Cigarettes 5) Plastic Bottle Cap	3.03
Middle	1) Plastic Food Wrapper 2) Tobacco Sachets 3) Other Tobacco Packaging 4) Cigarettes 5) Plastic Bottle Cap	4.20
Low	1) Tobacco Sachets 2) Plastic Food Wrapper 3) Cigarettes 4) Plastic Bottle Cap 5) Rubber Bands	2.74

Figure 27: Mumbai Map of Litter Density



Marine and riverine plastic pollution in Mumbai

Marine and riverine plastic pollution in Mumbai presents a significant environmental challenge, with detrimental effects on both aquatic ecosystems and public health. Various studies and reports have highlighted the severity of plastic pollution in the coastal areas and rivers of Mumbai.

The coast of Mumbai is identified as one of the most polluted seas in India (Bhattacharya et al., 2018), exacerbated by the presence of India's most polluting rivers around the city (Meijer et al., 2021). Researchers observed that plastic pollution primarily enters the ocean through drainage channels and rivers, along with sewage and industrial waste. In addition to India's robust laws to deal with plastic waste, river-directed efforts to mitigate this pollution include the implementation of initiatives like the Mithi River Cleanup pilot project (developed by Finland's Huhtamäki River Recycle Project), which utilizes specialized machinery for the mechanical removal of plastic waste.

However, despite such efforts, the scale of plastic pollution accumulating along the coast and in aquatic environments remains alarming (Figure 28). Studies have revealed substantial quantities of plastic debris, particularly in Mumbai's mangrove forests and beaches, both prominent land features of the seven-island conglomerate that makeup Greater Mumbai. Various types of plastics have been identified, including polystyrene, PVC, and PET (De et al., 2023; Selvam K et al., 2021; White, 2020), with significant proportions found in marine biota samples as well (Gurjar et al., 2022).

Tidal and monsoonal events play a crucial role in the transport of marine debris, with higher quantities observed during low tide conditions (Manickavasagam et al., 2020) and seaward flushing and monsoonal flux (Jayasiri et al., 2013). Plastic pollution not only poses environmental hazards but also threatens public health, as evidenced by the presence of microplastics in marine organisms (Gurjar et al., 2022).

Efforts by environmentalists and community members, such as Cleanup Versova Beach initiative led by Afroz Shah, demonstrate grassroots efforts to address plastic pollution. Despite existing laws and government regulations of plastic waste management, challenges persist in enforcing comprehensive solutions. Moving forward, a proactive circular economic approach to plastic, emphasizing the prevention of plastic waste rather than post-litter cleanup, should be implemented. Moreover, addressing legal ambiguities about accountability for ocean-bound plastic pollution is also essential for effective intervention strategies.

Figure 28: Example of dumping along river in Mumbai

(Photo Credit: CEE)

Opportunities and Recommendations

We recommend exploring the following opportunities to expand and enhance circularity in Mumbai 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 Mumbai within each spoke. The purpose of the forthcoming Opportunity Assessment Workshop in Mumbai 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. In addition, many of these opportunities are in synergy with a new report published in December 2023 by the India-Australia Industry and Research Collaboration for Reducing Plastic Waste. The National Circular Economy Roadmap for Reducing Plastic Waste in India summarizes that if actions are taken, by 2035, 80% of waste could be tracked digitally and then landfilling can be reduced by 30%, single-use plastics can be phased out over time, and recycling rates can increase to 67% (Dhodapkar et al., 2023).

INPUT

- Leverage Corporate Social Responsibility measures for top consumer goods brands to increase and incentivize buy-back and repurposing programs, such as Biserli's Bottles for Change program. This program works with NGOs, recyclers, and waste management agencies in ~10 cities across India to maximize collection of PET bottles, create clean and sustainable supply chains for recycled PET, and educate the public on source separation and the value of recycling (Biserli, 2020).
- With the high amount of domestic manufacturing locations (such as Hindustan Coca Cola Beverages, Hindustan Unilever, Moyora India, Balaji, and ITC Limited), there may be impactful opportunities around extended producer responsibility (EPR), particularly for the most problematic types of items and packaging.

COMMUNITY

- Any changes to the waste management system must be thought of in relation to environmental and social inequalities, as the interviewees tended to view all of these issues as inherently intertwined.

- Interviewees felt that some opportunities for change lie in decentralized, grassroots movements and championed policies related to EPR and plastic bans.
- The city should enhance communication and engagement with the community around low and zero waste options, including information about dry waste collection centers, the value of source segregation, the importance of reducing open dumping, the presence of deposit schemes, and other innovations in the city.
- Education should be coupled with effective infrastructure so that behavior changes are as straightforward and seamless as possible.

PRODUCT DESIGN

- Develop sustainable guidelines for guidelines for zero waste or low waste events in Mumbai, and consider capturing lessons learned from other UO cities.
- The city may want to explore conversations around product design with domestic manufacturers, particularly those in close proximity to Mumbai and for products packaged in material that has little value in recycling or is likely to end up in the environment.
- Expand upon the use of non-plastic and biodegradable (e.g., paper that does not have a plastic lining) products in to-go items particularly for restaurants and vendors that are still using plastic.
- This CAP component, as well as others tangentially related, may provide data to support India's Plastic Pact efforts to *eliminate, innovate and circulate* plastics and plastic packaging.

USE

- Enforcement of current product bans, particularly around single-use shopping bags, needs to be strengthened. Reusable bags should also be encouraged and incentivized, which were not offered as an option in any of the stores surveyed.
- Reuse infrastructure and reusable items were not readily found in Mumbai. Some small-scale companies were identified anecdotally for refill of products such as cleaning goods (such as Refillable), but they were not found during CAP fieldwork. This is an opportunity to expand on reuse and refill systems for items that make the most sense economically and culturally.

COLLECTION

- Strengthen messaging around sorting at source and identify geographic areas of concern to focus this work and increase household segregation.
- Improve and expand upon existing collection and sorting infrastructure, such as Dry Waste Centers and Material Recovery Facilities.
- Introducing and expanding upon plastic buyback programs, where citizens can exchange plastic waste for incentives (additional income), encouraging active participation in plastic waste management and promoting the concept of a circular economy.

END OF CYCLE

- Investments could be made in setting up new treatment facilities, upgrading existing ones, and exploring composting technologies to harness the resource potential of the waste. This would also enhance green jobs, skills, and opportunities in the city.
- Promoting private sector investment and entrepreneurial engagement in waste management can drive innovation and efficiency in waste treatment processes. Enterprises that have shown success in other cities, such as SWaCH (Pune) and Saahas (Bangalore).
- As a part of EPR initiatives and plastic buyback programs, producers can establish systems for collecting and recycling plastic packaging, thereby reducing the burden on municipal waste management systems.
- There is an opportunity to collaborate with non-governmental organizations (NGOs), citizen groups, and stakeholders to tackle plastic pollution collectively through joint awareness campaigns, clean-up drives, and adoption of sustainable waste management practices.
- The informal waste sector should be included in the system by collaborating with organizations like Parisar Bhagini Vikas Sangh, who work for the welfare and livelihoods of female waste pickers.
- Continued research, monitoring, and evaluation of interventions is an opportunity to plan for, refine, and optimize waste treatment practices into the future.
- The city may want to explore a unified waste service by zone or ward to accommodate the diversity of waste across areas in Mumbai, instead of a heavily fragmented system with multiple providers in each zone or ward.
- The city may consider investing in specialized WM processes, particularly for problematic streams such as sanitary waste.

LEAKAGE

- The city could explore the prioritization of one ward or a select number of wards initially, starting small to establish a model that can be further scaled.
- Expand outreach and education, instilling an understanding of the detrimental consequences of littering, the importance of waste segregation, and the far-reaching effects of environmental pollution.
- Explore using a diverse range of monitoring methods, including field surveys and/or remote sensing to facilitate the identification of pollution hotspots and track the movement of plastic waste. These can help guide targeted cleanup endeavors, enable the monitoring of the effectiveness of waste management practices, and engage community members as active participants to foster ownership and collective responsibility.
- Enhance community outreach and messaging around open dumping, particularly in and around waterways, starting with a comprehensive review of the most vulnerable areas to focus on for pilot programs.
- City officials and partners should address the large amount of waste leakage into the environment (including collecting regular data from rivers) as well as strengthening the collection system to prevent leakage upstream.
- UO and partner organizations may want to connect with Cleanup Versova Beach on a UO pilot in Mumbai, as well as other outreach and engagement organizations in the area to target waterway and coastal cleanups.

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Appendix

Table 8: Full List of Debris Tracker 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 Towels or rags Fabric Pieces Other Cloth
E-Waste	Batteries E-Waste Fragments Wire 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 Foil to-go container Metal Bottle Caps or Tabs Metal Fragments Other Metal
Organic Waste	Food Waste Other Organic Waste

Material	Items
Other	Other Popsicle or Lollipop Stick
Other Plastic Products	Bulk Bags Flip Flops or shoes Plastic String, Tape, or Packing Straps Rubber Bands Trash bag Tires Balloons Plastic toys or balls Car Parts Hard plastic jugs or containers Other Plastic
Food-Related Paper	Paper cups Paper food box or container Paper plates or bowls Compostable paper cups Paper food wrapper Compostable food box or container Napkins Other Food-Related paper
Paper	Office paper and newspaper Tags, tickets, and receipts Corrugated Cardboard Paper fragments Other Paper
Personal Care Products	Blister Pack or other pill packaging Cotton Buds Ear plugs Personal Care Product Sachet or packet Toothbrushes Toothpaste or Other Product Tube Flossers Feminine products Needles and syringes Other Personal Care Product

Material	Items
Food-related plastic	Foam cups Plastic cups Compostable plastic cups Cup Lids Plastic Bottle Aseptic cartons Mini alcohol bottles Plastic Bottle Cap Plastic Food Wrapper Condiment packet or container Plastic Grocery Bag Sandwich or snack bags Plastic Utensils Straws Foam to-go container or clamshell Plastic to-go container or clamshell Compostable plastic container or clamshell Other Food-Related Plastic
Plastic Fragments	Film Fragments Foam Fragments Hard Plastic Fragments Rubber/ tire fragments Other Fragments
PPE	Disinfectant Wipes Disposable Gloves Face Masks Other PPE
Tobacco Products	Cigarette Packaging Cigarettes Tobacco Sachets or packets E-cigarettes and vaping Plastic cigar/cigarillo tips Lighters Cannabis-related waste Other Tobacco Product

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