

State of Waste Management Report

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Table of contents

1	Executive Summary	8
2	Introduction	12
3	Existing legislation, initiatives & key institutions	15
3.1	Solid Waste Management	15
3.2	Plastic Waste Management.....	16
3.3	Waste Management Institutional Structure	18
4	Environmental Pressure on Select Cities	21
5	State of Waste Management in the Select Cities	23
5.1	East Delhi	23
5.2	Panaji, Goa	26
5.3	Surat.....	32
5.4	Varanasi.....	36
5.5	Raebareli.....	39
6	Best Practices.....	41
6.1	Indore: The Cleanest City in India.....	41
6.2	Maharashtra: Beed Swachhta Mission Organic Sahkari Samiti Model (BSMOSS)...	42
6.3	Surat:rom Garbage-Littered City to the Second Cleanest City in the Country	44
6.4	Kerala: Haritha Karma Sena	44
6.5	Panaji: Zero Waste,Zero Landfill Model.....	46
7	Findings & Recommendations	48
7.1	Key Findings and Identified Gaps.....	49
7.2	Recommendations.....	52
8	Appendices	64
	Appendix 1: List of Topics Covered & Experts and Entrepreneurs Invited for the Workshops	64
	Appendix 2: Summary of the Workshops Conducted.....	66

List of Tables

Table 1 Initiative and Various Policies by Government of India on Solid Waste Management	15
Table 2 Waste Processing Facilities in East Delhi	25
Table 3 The total five streams of waste	28
Table 4 Waste processing facilities in Panaji	30
Table 5 Wet Waste Processing Facilities' Capacity in Panaji, Goa	30
Table 6 Total Transfer Stations in Surat	35

List of Figures

Figure 1 Composition of waste in India.....	12
Figure 2 Timeline of Plastic Waste Management Rules in India.....	17
Figure 3 Alternatives to Single-use Plastic	17
Figure 4 Waste management institutional structure in India	19
Figure 5 Per capita per day waste generation (in kg) in the five select cities	22
Figure 6 The composition of MSW in East Delhi.....	24
Figure 7 Flow diagram of the MSWM system adopted by EDMC	24
Figure 8 Waste composition in Panjim	27
Figure 9 Flow diagram of the MSWM system adopted by CCP	27
Figure 10 way segregation	29
Figure 11 The composition of MSW in Surat	32
Figure 12 Flow diagram of the MSWM system adopted by SMC.....	33
Figure 13 Composition of MSW in Varanasi.....	37
Figure 14 Flow diagram of the MSWM system adopted by VMC.....	37

Abbreviations

ABS	Acrylonitrile Butadiene Styrene
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BioCNG	Bio Compressed Natural Gas
BOOT	Build Own Operate and Transfer
BSMOSS	Beed Swacchta Mission Organic Sahkari Samiti model
bWW	Be Waste Wise
CAP	Comprehensive Action Plan
CBOs	Community-Based Organizations
CCP	City Corporation of Panaji
CII	Confederation of Indian Industry
CIPET	Central Institute of Petrochemicals Engineering & Technology
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health, Environmental Engineering Organization
CRRRI	Central Road Research institute
CSR	Corporate Social Responsibility
DC	Designated Energy Consumers'
DfE	Design for Environment
DTDC	Door-to-Door Collection
DWM	Decentralized Waste Management
EDMC	East Delhi Municipal Corporation
EP	Environment Protection
EPC	Engineering Procurement & Construction
EPR	Extended Producer Responsibility
ETP	Effluent Treatment Plant
FBOs	Faith-Based Organizations
FCO	Fertilizer Control Order
GAIL	Gas Authority of India Ltd.
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GPS	Global Positioning System
GWMC	Goa Waste Management Corporation
HD	High Density
HDPE	High-density Polyethylene
ICT	Information Communication Technology (ICT)
ITC	Indian Tobacco Company
IEC	Information, Education & Communication
IFFI	The International Film Festival
ILFS Environmental	IL&FS Environmental Infrastructure and Services Ltd
IMC	Indore Municipal Corporation
IOCL	Indian Oil Corporation Limited
IoT	Internet of Things
IPCA	Indian Pollution Control Association

JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LARPM	Laboratory for Advanced Research in Polymeric Materials
LD	Light Density
LVPs	Low Value Plastics
MBR/RO	Membrane Bio-Reactor/Reverse Osmosis
MBT	Mechanical Biological Treatment
MLP	Multi-Layered Packaging
MMPA	Million Metric Tonnes Per Annum
MoEF&CC	Ministry of Environment, Forest, and Climate Change
MOHUA	Ministry of Housing and Urban Affairs
MRF	Material Recovery Facility
MSMEs	Micro, Small & Medium Enterprises
MSW	Municipal Solid Waste
NAMA	Nationally Appropriate Mitigation Action
NEWS	NTPC-EDMC Waste Solution Pvt. Ltd.
NGOs	Non-Governmental Organizations
NHAI	National Highway Authority of India
NREGA	National Rural Employment Guarantee
NTPC	National Thermal Power Corporation Limited
NUSP	National Urban Sanitation Policy
O&M	Operations & Maintenance
ODF	Open Defecation Free
ONGC	Natural Gas Corporation
OWCs	Organic Waste Converters
PAN India	Presence Across Nation
PET	Polyethylene Terephthalate
PIBOs	Producers, Importers, & Brand Owners
PP	Polypropylene
PPPs	Public Private Partnerships
PVC	Polyvinyl Chloride
PWM	Plastic Waste Management
RDF	Refuse Derived Fuel
RWA	Resident Welfare Associations
SBM	Swachh Bharat Mission
SDGs	Sustainable Development Goals
SEC	Specific Energy Consumption
SHGs	Self-Help Groups
SIE	Society for Indoor Environment
SLBs	Service Level Benchmarks
SLF	Secured Landfill Facility
SLRM	Solid and Liquid Resource Management Centers
SMC	Surat Municipal Corporation
SMEs	Small and Medium Enterprises

SPV	Special Purpose Vehicle
SS	Swachh Survekshan
SUPBs	Single Use Plastic Bags
SUDA	Surat Urban Development Authority
SUP	Single-Use Plastic
SWMR	State of Waste Management Report
SWYW	Shop with Your Waste
TERI	The Energy Resources Institute
TPD	Tonnes Per Day
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
UKRI	UK Research and Innovation
ULBs	Urban Local Bodies
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VMC	Varanasi Municipal Corporation
VNN	Varanasi Nagar Nigam
WMA	Waste Management Agency
WRAP	Worldwide Responsible Accredited Production
WTE	Waste-to-energy

1 Executive Summary

Waste management in India has greatly improved since the events of the 1994 Surat plague, where various policy changes and initiatives have led towards a paradigm shift in waste management for cities and panchayats across the country. Previously, India only had the Hazardous Waste (Management & Handling) Rules for solid waste management¹; following the plague, India developed critical rules, policies, schemes, and financial plans to improve overall waste management to better protect human health and the environment. However, a rapidly increasing rate of waste generation driven by urbanization, industrialization, and population growth is now posing new challenges to India's waste management infrastructure and system. In recent years, policy makers have identified waste management as a key priority and have been working towards establishing rules and policies to facilitate the implementation of effective waste management practices and systems in the country. This includes the central agency for environmental protection in India, the Ministry of Environment, Forest and Climate Change (MoEF&CC) who, along with other concerned departments, has undertaken a number of efforts to safeguard the country's natural environment and address waste management-related challenges.

State and city governments have the critical responsibility of municipal waste management for the communities within their respective jurisdictions. This complex task is even more challenging for states and cities with a high proportion of low-income communities that typically reside in slum areas and congested lanes. In such regions, establishing systematic waste collection and segregation systems are complicated due to a lack of accessibility, infrastructure, land space, cultural behaviour, and practices.

Along with the state and city government, the informal sector also plays a vital role in waste management, where approximately 15%-20% of total waste generated in India is collected, segregated and sent for recycling by informal waste workers. Undoubtedly, informal waste management activities help households and communities generate income and provide for their families, but they come at a tremendous cost in terms of the potentially adverse health effects on individuals who participate. Due to the societal disadvantages faced by those involved in informal waste management, serious issues of gender inequality, health disparity, and environmental injustice arise. India has the highest number of women working in the informal economy — 81.8% of women employed in India are employed in the informal sector² — and, more often than not, these women face multiple levels of discrimination which are invisible and neglected in policy-making processes. There are structural constraints and challenges at the workplace for women, which are not emphasized enough by the concerned authorities.

While several cities such as Indore, Surat, Mysore, Pune, and Panaji have implemented improved measures and have become torch-bearers of best practices in waste management in the country, there is still a lot to be learned about what is being done and what more

¹SWACHH BHARAT MISSION MUNICIPAL SOLID WASTE MANAGEMENT MANUAL Part II: the manual. (2016). [online] Available at: <https://mohua.gov.in/upload/uploadfiles/files/Part2.pdf>.

²Women and men in the informal economy: a statistical picture. (2018). Available at: https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_626831.pdf.

needs to be done to ensure that current best efforts and practices continue in the future. For this, a thorough assessment of the key priorities and challenges in waste management is required.

In this context, The Energy & Resources Institute (TERI), in partnership with The Incubation Network and Be Waste Wise (bWW), conducted 10 online workshops for a network of five cities (Surat, Panaji, Varanasi, East Delhi, and Raebareli) to (i) identify key priorities and challenges in municipal solid waste management in India; and (ii) provide a platform for capacity building and knowledge sharing among the public and private sector. The topics of the 10 workshops covered various aspects of municipal solid waste management including plastic waste, and the development of more effective and gender-sensitive waste management practices. The three workshops about improving gender sensitivity in the waste management sector attempted to understand how gender-inclusive waste management systems will accelerate progress toward waste management goals in the selected five cities.

As a part of the initiative, TERI has developed this State of Waste Management Report (SWMR) that is primarily based on the interactions and data generated from the five cities. The report outlines current waste management practices carried out by the selected cities and also puts forward the best practices undertaken by several other cities. The report also provides recommendations to city governments for effective municipal solid waste management at a city level, and includes a gap analysis from the discussions held through the workshops and public sessions held as part of the initiative.

A summary of key findings and proposed recommendations as outlined in the report are as follows:

1. Challenges in connecting national policies with local rules and bye-laws

Comprehending and implementing the multiple amendments made to the SWM Rules, 2016 at the municipal level is challenging due to the limited time between the new amendments and the implementation of the previous amendments. This tight timeline further effect in drafting the bye-laws at the city level, as they may need more time to modify their existing plans and systems to comply with the latest amendments. Moreover, with regard to the plastic waste management, the lack of awareness regarding the various provisions of EPR rules and ways to implement these rules at the municipal level has also created significant challenges in addressing the issues regarding plastic waste management.

Proposed recommendations are as follows:

1. Urban Local Bodies (ULBs) shall update local waste management bye-laws to incorporate amendments introduced by the central government in a timely manner.
2. To review and improve implementation of Extended Producer Responsibility (EPR) at city level and the integration of the informal sector within the framework.

2. Challenges in managing plastic waste

Effective plastic waste management faces several challenges. These include a limited technical understanding of how to efficiently track and manage single-use plastic (SUP) waste, as well as the lack of presence of viable alternatives to SUPs. Moreover, there is a

noticeable gap in public engagement, often stemming from insufficient social innovation and engineering initiatives, hindering progress in addressing plastic waste-related issues comprehensively.

Proposed recommendations are as follows:

1. Stricter monitoring standards are needed to successfully reduce the use of existing single-use plastic packaging waste and other plastic litter. Further, adoption of innovative decentralized plastic collection mechanisms, and assessing and analysing the locally-available alternatives to plastics are efficient ways for improving plastic waste collection and reducing plastic consumption, respectively.

3. Challenges in setting up necessary facilities for waste management

The scarcity of available land poses a significant hurdle in developing the necessary infrastructure. Furthermore, a lack of awareness and motivation amongst the stakeholder involved across the value chain of waste management inhibits the scaling-up of technologies, making it essential to address these issues comprehensively to ensure effective and sustainable solutions.

Proposed recommendations are as follows:

1. Technology interventions that can analyse the fundamental challenges and needs of the local waste management system are necessary.
2. At a granular level, awareness generation is the key to achieve a sound waste management system in a city.

4. Challenges in validating the efforts of informal waste workers

The integration of the informal waste workers into the formal system of waste management is hindered because of lack of incentives such as decent incomes, social security benefits, education, and skill development. Additionally, often informal waste workers are individuals migrated from other countries like Bangladesh in search of jobs and livelihood.

Proposed recommendations are as follows:

1. Validate the efforts of informal waste workers by positive communication and media strategies, providing ID cards, protective gear, health check-ups, social security schemes, and payment schedules.
2. The role of Community Based Organizations (CBOs), including women-led self-help groups, working in waste management must be acknowledged. Successful models could be replicated in other locations in the sector to uplift the lives of underprivileged communities in society.
3. The essential role of women in development of sustainable resource management must be recognized, and women must be given an equal position in public initiatives, political leadership, and decision making related to waste management.

5. Challenges in setting up viable business models

ULBs lack a self-sustaining revenue generating model through the provision of various waste management and disposal services and recycling solutions. For this stakeholder

involvement across the value chain is lacking. Further, the reluctance of private companies to engage in the waste sector due to various factors such as quality and procurement of the feedstock for the treatment plant further complicates the situation. Moreover, resistance from the local communities in cooperating with waste management services affects the functioning of a sustainable business model.

Proposed recommendations are as follows:

1. There is a need to establish new and innovative sustainable financing mechanisms for waste management at the city-level.
2. To explore the viability of expanding the utilisation of MSW-based RDF in cements plants, in compliance with environmental and social standards.
3. Increase allocation of CSR funds from industries and other organisations towards technology upgrades, deployment of waste-to-energy technologies, and for overall sustainable money flow in the MSW management.

2 Introduction

Waste, and its impact on human and environmental health, continues to be discussed across many national and international platforms due to rapidly increasing waste generation rates and the challenges it presents globally. Waste management is a crucial public service and is seen as a fundamental component for healthy communities and ecosystems. According to the Central Pollution Control Board (CPCB) annual report for 2020–21, India generates 160,038.9 tonnes per day (TPD) of solid waste, of which 152,749.5 TPD (95.40%) is collected, 79,956.3 TPD (50%) is processed, 29,427.2 (18.4%) TPD is landfilled; 50,655.4 TPD (31.7%) of the total waste generated remains unaccounted for.³ With the growth in industrialization, urbanization, and population, the amount of municipal solid waste (MSW) generated increased from 52.97 million metric tonnes per annum (MMTPA) in 2018 to 55 MMTPA in 2020.⁴ The amount of MSW generated per capita is increasing annually at a rate of 1.3%,⁵ and the total amount of waste generated is anticipated to rise to 165 million tonnes per year by 2031.⁶ The majority of the waste produced in India—about 50% of the total waste—is organic waste (see Figure 1).⁷

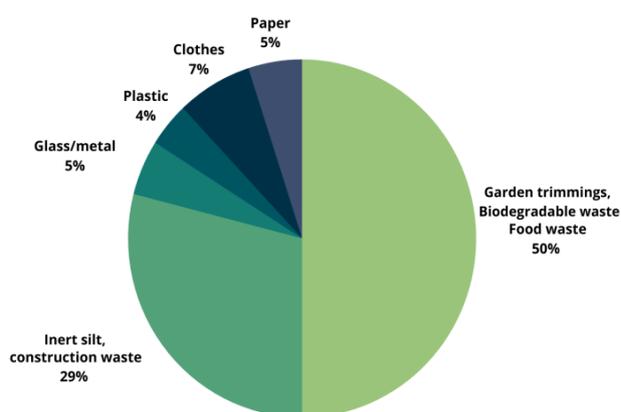


Figure 1 Composition of waste in India

In India, the key challenge of waste management is the on-the-ground implementation of waste management rules and lack of proper awareness among society regarding waste and its impact. Although good waste management is expensive, poor waste management comes at a much heavier cost to society and impedes overall economic growth.

Collected waste consists of both wet and dry waste and includes items that can be recycled, such as glass, metals, single-use

plastic bags (SUPBs), packaging debris, electronic equipment, and so on. Such materials, when contaminated, are not recyclable and wind up in dumpsites or landfills. Recycling waste can improve production efficiency, lower greenhouse gas (GHG) emissions, lower the cost of acquiring raw materials, and decrease the amount of waste that needs to be treated

³CENTRAL POLLUTION CONTROL BOARD (2021). Annual Report 2020-21 on Implementation of Solid Waste Management Rules, 2016. [online] CPCB.nic.in. Available at: https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf.

⁴CENTRAL POLLUTION CONTROL BOARD (2021). Annual Report 2020-21 on Implementation of Solid Waste Management Rules, 2016. [online] CPCB.nic.in. Available at: https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf.

⁵Guidelines for Preparation of Detailed Project Reports and Selection of Technologies for Processing and Final Disposal of Municipal Solid Waste Using 12Th Finance Commission Grants. (n.d.). [online] Available at: <https://mohua.gov.in/upload/uploadfiles/files/93.pdf>.

⁶pib.gov.in. (n.d.). Sustainable Processing of Municipal Solid Waste: 'Waste to Wealth'. [online] Available at: <https://pib.gov.in/PressReleasePage.aspx?PRID=1667099>

⁷CENTRAL POLLUTION CONTROL BOARD (2021). Annual Report 2020-21 on Implementation of Solid Waste Management Rules, 2016. [online] CPCB.nic.in. Available at: https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf

and disposed of. According to current estimates, India recycles 50% of the total MSW produced,⁸ while the remainder ends up in landfills, having a negative influence on the society's health, safety, and environment. As per CPCB's 2020-21 report, India has 1,924 identified landfills and 3,184 dumpsites/ unscientific landfill⁹ in total.¹⁰

Local governments bear the responsibility for proper solid waste management. Without a comprehensive waste management framework and its proper implementation, waste is discarded in the streets, in public spaces, into sewers, streams and other waterways, or it is openly burned as a means to reduce waste piles. The condition of waste management of a city always denotes the overall ability and performance of a municipality. India's urban population increased by 2.32% from 2020 to 2021, reaching per capita solid waste generation of 119.07 gm/day.¹¹ In cities with high industrial activity and a dense population, effective solid waste management is a major challenge. Various municipalities in India have undertaken multiple centralized and decentralized initiatives, such as Surat (material processing), Ambikapur (landfill management), Indore (source segregation), and Mysore (biodegradable waste management); these are all leading examples of a movement away from the conventional methods of handling municipal solid waste towards a system that is more financially and environmentally sound. Additionally, by enforcing bye-laws in their jurisdiction, cities are putting greater emphasis on collection of waste from all sources, segregation of waste at source, user fee collection and levying of fines and penalties, establishment of recycling centres, maintenance of waste management infrastructure, and channeling waste to wealth through recovery, reuse, and recycling.

As more information about the scale of the waste management issues and its impacts are being published, India has started to develop roadmaps for sustainable resource management to enhance the circular economy. As part of this effort to enable effective municipal solid waste management in India, The Incubation Network, in collaboration with TERI and bWW, selected five cities (Surat, Panaji, Varanasi, Delhi, and Raebareli), which are a mix of coastal and non-coastal cities with diverse demographics and waste management approaches. These five cities were chosen to strengthen the capabilities of the ULBs in different aspects of MSW management, including plastic waste, and develop more effective and gender-sensitive waste management regions.

As part of this initiative, TERI conducted 10 online workshops, with the participation of identified experts in the field of waste management and city officials from the five cities. The sessions also provided a platform for entrepreneurs to pitch their business so that ULBs are aware of their activities and can implement similar initiatives in their respective cities. This

⁸CENTRAL POLLUTION CONTROL BOARD (2021). Annual Report 2020-21 on Implementation of Solid Waste Management Rules, 2016. [online] CPCB.nic.in. Available at: https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf.

⁹A per the SWM rules, 2016, "dump sites" means a land utilized by local body for disposal of solid waste without following the principles of sanitary land filling; Whereas as per the CPHEEO Manual The term 'landfill' is used to describe a unit operation for final disposal of 'Municipal Solid Waste' on land, designed and constructed with the objective of minimum impact to the environment

¹⁰CENTRAL POLLUTION CONTROL BOARD (2021). Annual Report 2020-21 on Implementation of Solid Waste Management Rules, 2016. [online] CPCB.nic.in. Available at: https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf.

¹¹CENTRAL POLLUTION CONTROL BOARD (2021). Annual Report 2020-21 on Implementation of Solid Waste Management Rules, 2016. [online] CPCB.nic.in. Available at: https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2020-21.pdf.

State of Waste Management Report (SWMR) has also been developed by TERI, primarily based on the interactions and data generated from the five cities.

3 Existing legislation, initiatives & key institutions

The United Nations Conference on the Human Environment held in Stockholm in 1972 laid the foundation for the idea of sustainable development, which led to the establishment of the Environment (Protection) Act, 1986 in India. Developed with the aim to put the decisions of the UN Conference on the Human Environment into practice, the Act outlines provisions for environmental protection, environmental betterment, and the prevention, management, and mitigation of environmental pollution from all sources.¹² There are several rules in place to govern areas like waste minimization, recycling, reuse, solid waste, plastic waste, e-waste, and hazardous waste, and so on. The rules, comprising the Solid and Plastic Waste Management Rules, were elaborated under sections 3, 6, and 25 of the EP Act 1986.

3.1 Solid Waste Management

The Ministry of Environment, Forest, and Climate Change (MoEFCC) published the Solid Waste Management (SWM) Rules, 2016, which replaced the Municipal Solid Waste (MSW) (Management and Handling) Rules, 2000. The Solid Waste Management guidelines are designed to govern the segregation, storage, collection, transport, processing, and disposal of solid waste. Following the 1994 plague epidemic in Surat, a focused policy approach to solid waste management was initiated. Since then, the Government of India has launched numerous measures to enhance solid waste management in the nation, including the Swachh Bharat Mission (SBM) to improve sanitation in India; the Smart Cities programme, where some cities have incorporated improved waste management as one of their action items; the timely amendments to the Solid Waste Management Rules, 2016; and introducing Swachh Survekshan (SS) as a competitive framework to motivate cities to improve their urban sanitation conditions while promoting widespread citizen participation, waste-to-energy conversion, and composting. Table 1 highlights the measures taken by the Government of India that guide the provision of SWM services in the country.

Table 1 Initiative and Various Policies by Government of India on Solid Waste Management

Year	Rules, Policies, Schemes, Financial Plans
1973	Criminal Procedure Code, 1973
1974	The Waste Act (Prevention and Control of Pollution), 1974
1994-95	MSWM strategy paper by NEERI
1995	The J.S. Bajaj Committee Constituted by the Planning Commission
2000	Draft policy paper detailing the funding issues and requirements for MSWM by the Central Public Health, Environmental Engineering Organization (CPHEEO)
2005	The recommendations of the Technical Advisory Group on MSWM (2005)
2005	The 12 th Finance Commission allocated Rs 2,500 Cr for solid waste management for the period 2005–2010
2005	JNNURM (2005–2012)—40 MSW projects costing Rs 2,186 Cr sanctioned from a total of 65 cities covered

¹²THE ENVIRONMENT (PROTECTION) ACT, 1986.(n.d.). [online] Available at: https://www.indiacode.nic.in/bitstream/123456789/4316/1/ep_act_1986.pdf.

Year	Rules, Policies, Schemes, Financial Plans
2005	Report of the Technology Advisory Group on SWM
2006	Strategy and Action Plan-Use of compost in cities
2007	The 11 th Five-Year Plan allocated Rs 2,210 Cr for MSWM for the period 2007–2012
2008	National Urban Sanitation Policy (NUSP)
2008	Service Level Benchmarks (SLBs) in MSWM
2010	The 13 th Finance Commission for establishing standards for delivery of essential services for the period 2010–2015
2010	National Mission on Environmental Health and Sanitation
2011	Toolkit for Public Private Partnership Frameworks in Municipal Solid Waste Management
2012	Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT)
2014	Swachh Bharat Mission
2015	Atal Mission for Rejuvenation and Urban Transformation (AMRUT)
2015	The Smart Cities programme
2016	Swachh Survekshan introduced by Ministry of Housing and Urban Affairs (MoHUA)
2019	Solid Waste Management (Amendment) Rules, 2019
2020	Solid Waste Management (Amendment) Rules, 2020
2020	Program on Energy from Urban, Industrial, Agricultural Wastes/ Residues and Municipal Solid Waste

(Source: (MoUD, 2016))¹³

As part of the mandatory reforms required by the JNNURM, now known as the AMRUT, ULBs must promote public private partnerships (PPPs) for MSW management. Following this, the MoHUA issued an advisory to all state governments advising them to investigate the possibilities of incorporating PPP into SWM projects as well as including NGOs, CBOs, and resident welfare associations (RWAs) in the planning, implementation, operation, and maintenance of SWM services. All of these measures sparked much-needed momentum in the waste management sector, which is vital to improving general hygiene and societal well-being.

Such efficacious rules have had several positive trends, including households successfully adopting the practice of waste segregation; the integration of women-led self-help groups (SHGs) to create employment opportunities for them and other marginalized communities; and exploration of use of waste to create alternative forms of energy, amongst other positive social and economic impacts.

3.2 Plastic Waste Management

Many types of waste that enter the municipal solid waste stream are also subject to strict regulations. The Plastic Waste Management (PWM) rules are one example. The PWM rules prohibit the usage of certain types of plastic items, as well as the unregulated disposal of plastic. They emphasize source segregation, recycling, and reuse of plastic waste, as well as promoting the circular economy through the implementation of Extended Producer

¹³SWACHH BHARAT MISSION MUNICIPAL SOLID WASTE MANAGEMENT MANUAL Part II: the manual. (2016). [online] Available at: <https://mohua.gov.in/upload/uploadfiles/files/Part2.pdf>.

Responsibility (EPR). In this context, the Government of India has implemented a number of steps, including prohibitions and sanctions, in an attempt to minimize plastic use. Figure 2 below depicts a timeline with the various amendments of the PWM Rules that have been passed by the MoEFCC.

Since July 1, 2022, the Ministry of Environment, Forest and Climate Change (MoEFCC), has prohibited the use of 19 single-use plastic items which include ear-buds with plastic shafts, plastic flags, plates, glasses, styrofoam decorative items, and more. Despite the ban, there are several implementation challenges across stakeholders. These challenges are mainly due to the lack of widely-available and affordable plastic alternatives.



Figure 2 Timeline of Plastic Waste Management Rules in India

(Source: Compiled by study authors)

In September 2021, the MoEFCC proposed a ban on polythene bags smaller than 75 microns, as opposed to the 50 microns previously envisaged in the Plastic Waste Management (PWM) Rules, 2016. Furthermore, the PWM Rules 2016 already prohibit the use of plastic in sachets for packing, storing, or selling pan masala, gutkha, or tobacco, among other items. It should be noted that the current ban only applies to a few additional single-use plastic categories, and excludes multi-layered packaging (MLP) from the list.



Figure 3 Alternatives to Single-use Plastic
(Source: CPCB)

The development of a circular plastic economy is one of the most important strategies for reducing plastics usage and pollution. The circular economy requires the development of markets for reusing and recycling resources. In this regard, the India Plastics Pact (IPP) was announced in 2021 as a collaboration between WWF India and the Confederation of Indian Industry (CII). The pact is supported by UK Research and Innovation (UKRI) and Worldwide Responsible Accredited Production (WRAP), and it has been endorsed by the

British High Commission in India. The aim of the pact is to convert the current linear plastics system into a circular plastics economy, which will minimise plastic usage, retain valuable materials in the economy for use in other goods, and provide jobs, investment, and possibilities in the plastics system in India.

The onset of a circular plastics economy is advanced with the introduction of extended producer responsibility (EPR). In India, the concept of EPR was first introduced in the E-Waste (Management and Handling) Rules 2011. EPR was subsequently included in the Plastic Waste Management Rules, 2016, which outlined the responsibilities of plastic Producers, Importers, & Brand Owners (PIBOs) on take-back, recycling, and final disposal of their respective products and packaging at the end of their lifecycle, in line with the “Polluters Pay” principle.

3.3 Waste Management Institutional Structure

In India, the administration and management of SWM is separated into three tiers: central, state, and urban local bodies (ULBs). The MoEFCC is the central agency for implementing pollution prevention and abatement policies and programs, as well as natural resource conservation.

The other key actors such as the Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCB), Urban Local Bodies (ULBs), and village panchayats (an elected body in India meant to find solutions to local issues, such as placing a proper system for solid waste management, regulating taxes, interventions, and more) coordinate on activities with each other and administer the environmental laws and policies across the nation and within their respective jurisdiction for environmental protection. ULBs and village panchayats inform the design of bye-laws, develop solid waste management strategies, and conduct awareness generation and other similar initiatives along with the key actors such as waste pickers, self-help groups (SHGs), and non-governmental organizations (NGOs), as demonstrated in Figure 4. Such public-private, public-community, and public-private-community partnerships develop agreements to deliver a range of solid waste management-related services such as collection, transportation, treatment, disposal, and recycling.

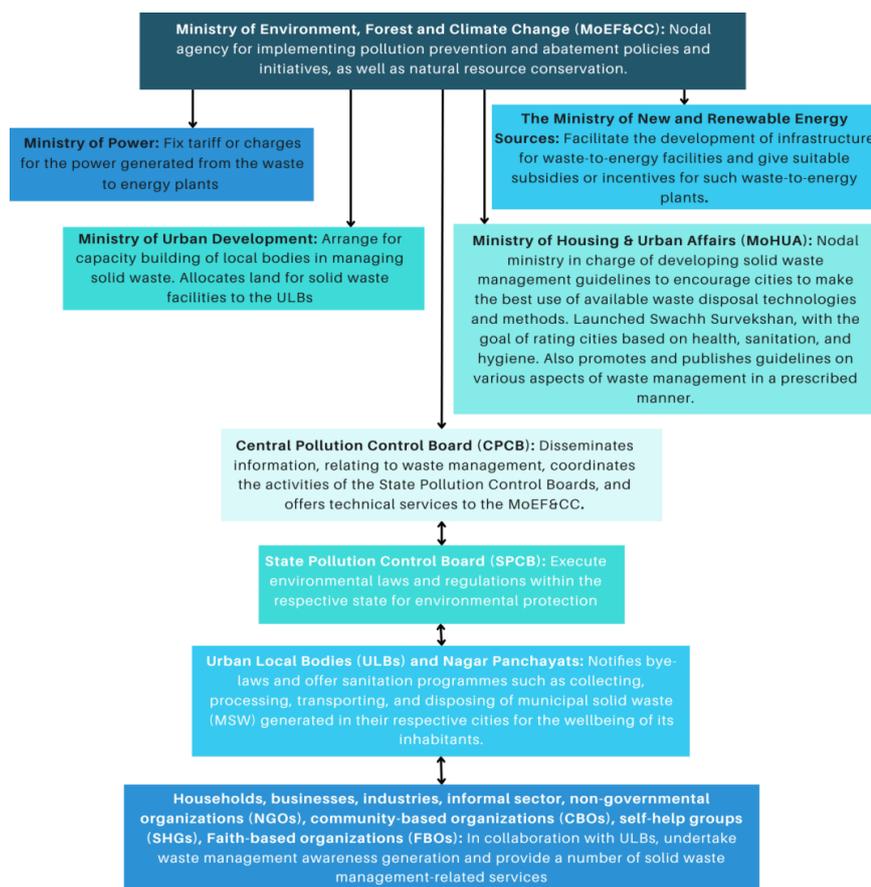


Figure 4 Waste management institutional structure in India
(Source: Compiled by study authors)

As more waste management laws and initiatives are implemented in the country, improvement in the country's waste management scenario is noticeable. For instance, since the Swachh Bharat Mission or the Clean India Mission, sanitation has been discussed at various forums such as the International Sanitation Convention, United Nations General Assembly, and World Economic Forum. Several states and cities in India, like Panaji, Kerala, Surat, and Indore, are showcasing positive progress towards SWM, despite the challenges across the value chain from cradle to grave. With a mere capacity of 18% in waste treatment in 2014 to an increase in capacity of 73% in 2021, India has made significant progress.¹⁴ However, there is much to learn from other countries or cities in India itself. For this, a complete evaluation of the key priorities and challenges to waste management must be conducted to understand the current practices in place, and the necessary gaps to address to guarantee that the existing best initiatives and practices continue in the future.

A number of areas that the country needs to address to speed the transition of waste to resources includes: treating legacy waste¹⁵ at dumpsites; informal waste sector formalization; strengthening the monitoring of implementation of environmental rules and

¹⁴pib.gov.in. (2022). Waste processing capacities of urban local bodies (ULBs) increased from a mere 18% in 2014 to 73% at present: Shri Hardeep S. Puri. [online] Available at: <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1863445>

¹⁵ Legacy waste refers to old MSW in landfills or dumpsites.

legislation such as plastics ban and EPR; and allocating adequate funds to further strengthen existing waste management infrastructure.

4 Environmental Pressure on Select Cities

Though the industrial revolution came late to India, modernization has since influenced population growth. According to a 2020 study by Abhishek Dutt. et al.,¹⁶ when compared to the other ten most populated cities in India, in terms of MSW generation growth, Surat and Delhi expanded at alarming rates of 2,172% and 1,036% respectively from 1971 to 2015, most likely due to the fact that Delhi and Surat are two of India's fastest developing business and industrial cities.

Increased income and economic expansion have an influence on waste composition as well. Wealthier individuals consume more, resulting in a higher volume of packaging and other materials entering the waste stream, such as metals, plastics, glass, textiles, and so on. Changing income levels have an impact on the waste composition and amount of waste generated, which further influences the waste management techniques employed. This highlights and emphasizes the dire need for policy changes that developing countries must implement.¹⁷

Table 2 Population of the selected cities

Cities	2011	2021	2031
East Delhi	17,09,346	19,65,235	22,03,233
Varanasi	36,76,841	41,48,622	46,41,212
Surat	44,66,826	57,73,000	65,64,034
Panaji	40,017	45,800	51,320
Raebareli	34,05,559	38,42,531	42,98,777

(Source: Compiled by the report team)

As per Census 2011, the population in the selected 5 cities ranges from 40,017 to 44,66,826. The population in these cities has maintained an upward trend, with Raebareli showing the smallest growth in population.

The selected five cities receive floating populations in the range of 15,287 to 30,78,479 per year. For instance, Panaji is the capital of Goa, which is a renowned tourist destination with beaches and heritage sites. In 2018, it was estimated that Goa had a permanent population of around 1.58 million and a floating population of around 7 million tourists. This large floating population is also a huge contributor to the amount of waste generated in the city. Another tourist destination is Varanasi, where some of the prominent waste categories found can be attributed to religious and ritual activities. For ages, Varanasi has held an unparalleled significance as the foremost destination for Hindu pilgrims. Garlands and synthetic clothes used for religious purposes are commonly discarded as waste at these

¹⁶Dutta, A. and Jinsart, W. (2020). Waste generation and management status in the fast-expanding Indian cities: A review. [online]Journal of the Air & Waste Management Association. Available at: <https://www.tandfonline.com/doi/full/10.1080/10962247.2020.1738285>

¹⁷Hussain, M.T.T. and Behaylu, A. (2015). Scenario of Present and Future of Solid Waste Generation in India: A Case Study of Delhi Mega City. Journal of Environment and Earth Science, [online] 5(8), p.83. Available at: <https://www.iiste.org/Journals/index.php/IEES/article/view/22029>

locations. The common practice of immersing religious offerings in water is also a cause of marine litter in Varanasi.¹⁸

The solid waste generation per capita per day in the five cities ranges from 0.45kg to 1.24kg, with an average of 0.718 kg. From the graphical representation below (Figure 5) it is observed that Panaji, a tourist destination, has a much higher waste footprint among the five cities.

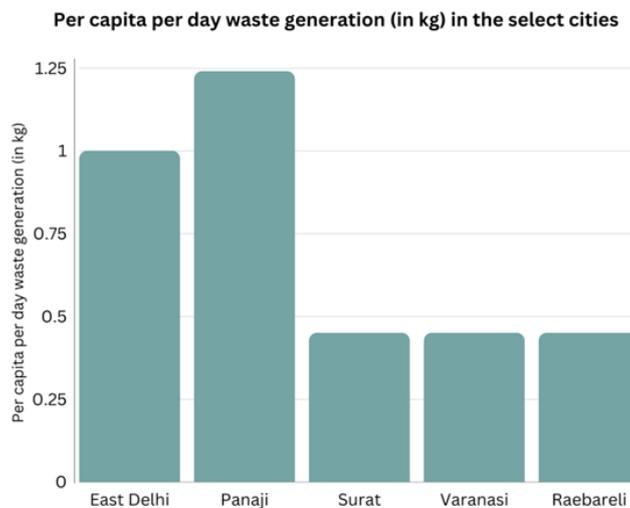


Figure 5 Per capita per day waste generation (in kg) in the five select cities

¹⁸Planet Rescue 101. (2020). How to tackle religious waste in India? [online] Available at: <https://planetrescue101.design.blog/2020/10/09/religious-waste-in-india/#:~:text=As%20an%20example%2C%20the%20Varanasi>

5 State of Waste Management in the Select Cities

5.1 East Delhi

East Delhi (also known as Trans Yamuna) is an administrative district of the National Capital Territory of Delhi. It is bounded by the border of Uttar Pradesh. It has an area of 105.98 sq.km, and has a population of 1,709,346 (Census 2011). East Delhi is well-known for having the city's oldest and largest waste dumpsite, the Ghazipur dumpsite. The Ghazipur dumpsite receives almost 3,000 TPD of waste every day, and at present is around 65 metres tall¹⁹ and covers 70 acres of land.²⁰

5.1.1. Solid Waste Management in East Delhi

The waste generated in the East Delhi area is managed by the East Delhi Municipal Corporation (EDMC). The comprehensive operation of collection including secondary collection, street cleaning, waste transportation and waste disposal is all done by EDMC. EDMC occupies 64 wards of Delhi and comprises two zones: Shahdara South and Shahdara North. The management of solid waste consists of sweeping, collection, storage, transportation and disposal of garbage.

The district of East Delhi generates 2,700 tonnes of waste per day. Out of the total waste generated, 100% waste is collected²¹; 100% segregation is happening in 3 Model Wards, 75% segregation in 6 Wards, and 30% segregation in 55 Wards; 26% of waste is processed/treated; and 74% of waste is disposed of in landfills.²² East Delhi has one waste-to-energy plant at Ghazipur with a capacity of 1,300 TPD.²³

The largest share (47%) of the waste produced in East Delhi is biodegradable waste. Figure 6 depicts the composition of MSW in East Delhi.

¹⁹The Indian Express. (2020). Explained: How Ghazipur landfill's height was reduced and if it can be permanently cleared. [online] Available at: <https://indianexpress.com/article/explained/ghazipur-landfill-height-reduced-permanently-cleared-6522978/>.

²⁰Solid Waste Management. (2020). [online] Available at: <https://dpcc.delhigovt.nic.in/uploads/pdf/Status-of-Solid-Waste-Management-in-Delhipdf-83e80619a099843e1cb437a00af5c09d.pdf>

²¹Solid Waste Management. (2020). [online] Available at: <https://dpcc.delhigovt.nic.in/uploads/pdf/Status-of-Solid-Waste-Management-in-Delhipdf-83e80619a099843e1cb437a00af5c09d.pdf>

²²DELHI POLLUTION CONTROL COMMITTEE (2020). Submission of Compliance Report of Govt. of NCT of Delhi regarding compliance of Municipal Solid Waste Rules, 2016. [online] DPCC. Available at: <https://www.dpcc.delhigovt.nic.in/uploads/pdf/Compliance-Report-submitted-to-CPCB-on-28-02-2020-SWMPDF-5f75ae29a529f7162d6edd33f75a5482.PDF>

²³Solid Waste Management. (2020). [online] Available at: <https://dpcc.delhigovt.nic.in/uploads/pdf/Status-of-Solid-Waste-Management-in-Delhipdf-83e80619a099843e1cb437a00af5c09d.pdf>

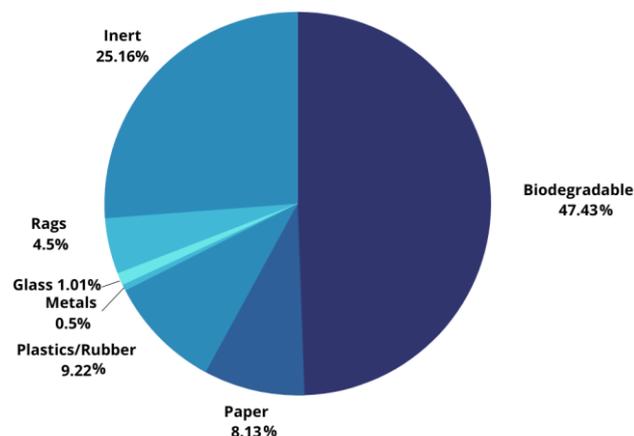


Figure 6 The composition of MSW in East Delhi

Source: NEERI 1996, 2011. www.cpcb.nic.in

The EDMC has taken several initiatives to implement the provisions of SWM rules 2016, and the East Delhi Municipal Corporation Solid Waste Management bye-laws 2017, which are mentioned below.

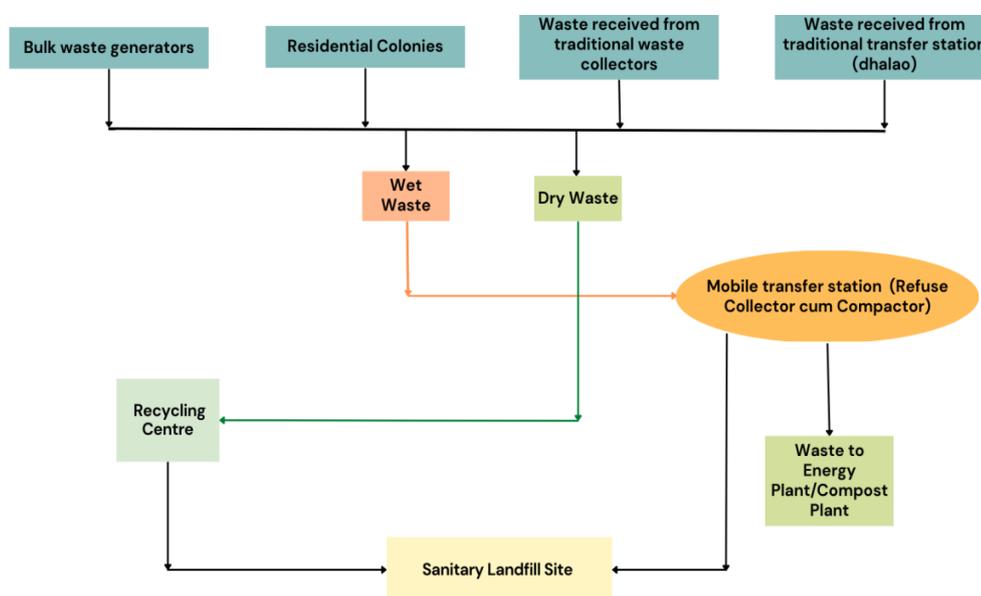


Figure 7 Flow diagram of the MSWM system adopted by EDMC

(Source: Compiled by study team)

5.1.2. Collection, Segregation, and Transportation

In East Delhi, in addition to regular door-to-door waste collection by the workers deployed by the EDMC, Safai Karamcharis, or manual scavengers, sweep the roads and footpaths, collect waste, and put it in municipal receptacles, dalaos and dustbins. The waste produced in EDMC is transported to Secured Landfill Facility (SLF) sites or processing facilities. The EDMC has installed mechanical sweeping systems with mechanical sweepers on roads with

right-of-way of 60'²⁴ and above, and is now operating four mechanical sweepers on the roads.

5.1.3. Processing and Treatment

The EDMC utilizes both a centralized and decentralized approach to processing waste. Table 2 depicts the waste processing facilities in East Delhi.

Table 2 Waste Processing Facilities in East Delhi

Decentralised Composters of 1 TPD Capacity

- 10 Plants commissioned
- 1 Plant at Vishwas Nagar to be commissioned by October 2022

Bio-Methanation Plants 5 TPD Capacity

- 2 Plants at Geeta Colony and Shastri Park have been commissioned

100 TPD Bio-Methanation plant at Ghazipur

2 TPD Micro Recovery Facility (MRF) at Shahdara South Zone, Geeta Colony, Delhi

Integrated solid waste processing facility at Ghonda Gujran

EDMC proposed a joint venture with National Thermal Power Corporation (NTPC) to establish an Integrated Solid Waste Management Facility for 2,000 TPD at Ghonda Gujran. The facility will produce 12 MW of power. A Special Purpose Vehicle (SPV), a subsidiary company that is formed by a parent company to undertake a specific activity, operating under the name of M/s. NTPC-EDMC Waste Solution Pvt. Ltd. (NEWS) has been formed for this project.

The following are major project components:

- MSW pre-processing facility
- System for storing processed waste
- 1200 TPD bio-methanation plant
- 200 TPD of construction & demolition waste processing facility

Waste-to-energy plant at Ghazipur:

The waste-to-energy plant at Ghazipur has a capacity of 1,300 TPD and generates 24 MW electricity from burning waste.²⁵ The facility is run by IL&FS. The facility receives mixed waste in a covered pit which undergoes pre-processing. In pre-processing, manual segregation on moving conveyor belts takes place to sort large waste such as construction & demolition waste, sanitary hardware, and plastic material. For the treatment of leachate, a

²⁴Road land width (also termed the right-of-way) is the land acquired for road construction purposes and provision of utilities along the length of road. IRC: 73-2020 "Geometric Design Standards for Rural (Non-Urban) Highways" (First Revision), Available at: <http://www.irc.nic.in/admnis/admin/showimg.aspx?ID=235>

²⁵DELHI POLLUTION CONTROL COMMITTEE (2022). Annual Report in Form V in respect of NCT of Delhi for the Year 2021-2022 on the Implementation of Solid Waste Management Rules, 2016. [online] DPCC. Available at: <https://www.dpcc.delhigovt.nic.in/uploads/pdf/AnnualReportSWM2021-2022pdf-dac617c79a20231c748458e59c29f441.pdf>

wastewater by-product, an Effluent Treatment Plant (ETP) has been installed at the Ghazipur facility.

5.1.4. Disposal

In the district of East Delhi, after the processing of waste, the remaining materials are sent to the over-utilised landfill site in Ghazipur. The Ghazipur landfill is a non-engineered and unscientific site.²⁶ Remediation of legacy waste at Ghazipur is being carried out as per the directions of the Hon'ble National Green Tribunal (NGT), including order dated 17.07.2019 in OA No. 519 / 2019. Hon'ble NGT has directed the EDMC to conduct bio-mining of the waste instead of capping the dump sites at Ghazipur.

5.2 Panaji, Goa

The capital city of Goa, Panaji encompasses an area of 8.27 km². It has a population of 40,017 as of 2011. As it is the country's most popular tourist destination, the city receives a huge number of floating population each year: 7 million in 2018 alone. The Corporation of the City of Panaji (CCP) is Asia's oldest civic entity. Panaji has a projected population of 45,800 people (according to a study by Royal Koning) in December 2021 along with a floating population of 16,708 persons/day, having a population density of 5,336/km² (according to city sanitation plan). The city has 30 administrative wards, and has been further divided into 12 zones for waste management purposes.

5.2.1. Solid Waste Management in Panaji

The waste generated in the city is managed under CCP. The CCP sends the collected waste for processing and treatment and has established various waste treatment facilities such as Saligao Plateau, currently operating at 250 TPD, and Cacora, at 100 TPD. Presently, Goa Waste Management Corporation (GWMC) makes special provision for securing the orderly establishment and development of facilities for management of various types of wastes, and is in the process of setting up an integrated municipal waste management facility with 250 TPD at Verna Industrial Estate and one proposed site at Bainguinim with 100 TPD.

Being one of the highly active tourist destinations leads to more waste generation in the city. The city generates around 55 TPD of waste each day mainly from its 16,000 houses, 470 hotels and restaurants, markets, street cleaning, and commercial facilities. According to CCP, dry waste accounts for 12 TPD, wet waste accounts for 28 TPD, about 40% of which comes from hotels and restaurants, and garden waste accounts for 9 TPD. About 6 TPD of the waste is not collected and is dumped at locations convenient to waste generators resulting in what is referred to locally as black spots. Among the waste collected, the majority of the waste (46.3%) comprises biodegradable waste.

²⁶ [DELHI POLLUTION CONTROL COMMITTEE \(2022\). Annual Report in Form V in respect of NCT of Delhi for the Year 2021-2022 on the Implementation of Solid Waste Management Rules, 2016. \[online\] DPCC. Available at: https://www.dpcc.delhigovt.nic.in/uploads/pdf/AnnualReportSWM2021-2022pdf-dac617c79a20231c748458e59c29f441.pdf.](https://www.dpcc.delhigovt.nic.in/uploads/pdf/AnnualReportSWM2021-2022pdf-dac617c79a20231c748458e59c29f441.pdf)

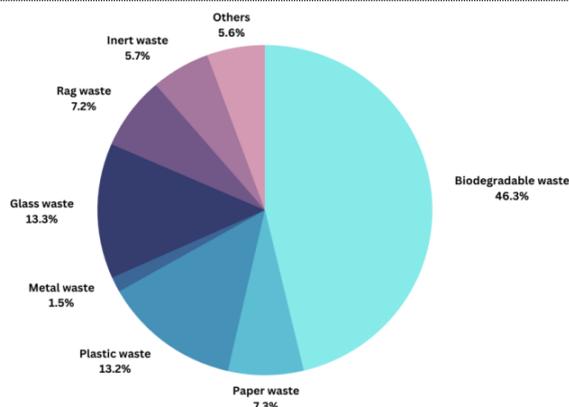


Figure 8 Waste composition in Panjim

(Source: CCAC (2020) Solid Waste Management City Profile Waste Initiative, Panaji, India)

The legislation governing MSW management in the city are the Model Municipal Solid Waste (Management and Handling) Bye-laws, 2020, adopted by the Panaji municipal corporation, and the Solid Waste Management Rules, 2016.

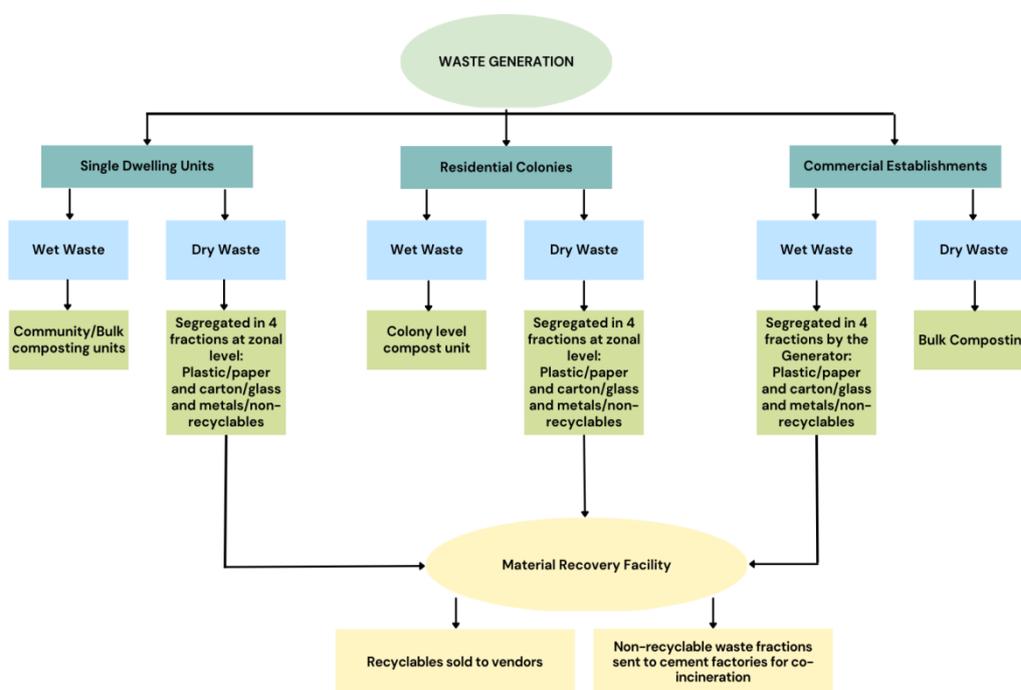


Figure 9 Flow diagram of the MSWM system adopted by CCP

(Source: Compiled by study team)

5.2.2. Collection, Segregation, and Transportation

In 2003, the CCP implemented a Door-to-Door Collection (DTDC) system for segregated waste, which required waste to be separated into two primary categories: biodegradable/organic waste (wet waste), and non-biodegradable/inorganic waste (dry waste). CCP personnel then segregate the dry waste into four streams once it is aggregated. CCP collects nearly 100% of MSW from households through DTDC services with the assistance of 629 municipal as well as contractual and daily wage workers. CCP launched a 'five-way segregation' system in September 2011, particularly focused on big businesses with

substantial waste generation, as well as housing societies and flats, to improve recovery and recycling levels.

Table 3 The total five streams of waste

Colour of Bins	Colour of Bags	Type of Waste
Green Bin	Green bags	Wet waste (Kitchen waste, cooked food waste, garden and leaf litter, flowers etc.)
Black Bin	Orange bag	Plastic (bottles, cups, containers, bags etc.)
	Black bags	Glass and metals (cans, aluminium foils, broken glass bottles +,etc.)
	Pink bag	Paper and cartons (newspapers, white and coloured paper, tissues, brown paper, Tetrapak etc.)
	White bag	Non-recyclables (Thermocol, leather, rubber, glossy paper, cloth, vinyl, rexine, etc.)

The five-way segregation policy now has been upgraded to a 16-way segregation. Strictly following the principle of Zero Waste Zero Landfill, CCP guides residential complexes, hotels, restaurants, government buildings, and hospitals to separate their waste into the following 16 categories:

- 1) Paper
- 2) Cardboard
- 3) Polyethylene terephthalate (PET) and hard plastics
- 4) Soft plastics
- 5) Coconut shells, fiber, and tender coconut
- 6) Cloth
- 7) Glass
- 8) Sharp objects
- 9) Metals
- 10) Ceramic & Melamine
- 11) E-Waste
- 12) Light bulbs, compact fluorescent bulbs, and tubes
- 13) Batteries
- 14) Non-Recyclables
- 15) Sanitary & Biomedical Waste (Domestic)
- 16) Expired/Used Medicines



Figure 10 way segregation
Source: CCP

According to recent statistics, 52% of households practice 2-way segregation, 33% practice 4-way segregation, and 15% practice 16-way segregation methods.

While dry waste is collected twice a week and wet waste is collected daily from both households and commercial establishments, hotel waste (both dry and wet waste components) is collected on a daily basis by CCP. The wet waste from hotels and markets is sent for composting, while the dry waste components are sent to the MRF in St.Inez.

CCP deploys a fleet of vehicles with separate wet and dry waste sections to transport the segregated waste. CCP has recently initiated GPS tracking of its fleet. As the city of Panaji doesn't have a landfill or dumping site, the segregated waste is transported to 6 decentralized facilities. In addition to this, GWMC offers waste management services like Village Panchayat Waste Pickup, where daily waste is picked up on demand by the village panchayat or educational institution. Garbage will be monitored strictly by the Goa Pollution Control Board and panchayats will have to send garbage in trucks with leachate tanks, so that waste should not fall or flow on the roads.

Since 2021, Feedback Foundation, an NGO, and UNEP have implemented the 'Plastic Recycling Management Programme' in Panaji. This initiative aims to reduce the negative effects and threats to the environment and human health by improving sustainable plastic waste management practices using a socio-technical approach that combines educational efforts to improve segregation, collection and recycling with increased regulatory oversight. This effort is in-line with the Swachh Bharat Mission. Door-to-door visits and training sessions are also being conducted to raise awareness about the ill effects of plastic and to mobilize the community for source segregation of waste.

5.2.3. Processing and Treatment

CCP treats biodegradable (wet) waste through a combination of centralised and decentralised composting, and also has a centralised MRF to sort non-biodegradable (dry) waste for recycling. CCP's current waste processing facilities are depicted in table 4.

Table 4 Waste processing facilities in Panaji

<p>Wet waste composting:</p> <ul style="list-style-type: none"> • 3 centralized plants (Heera, LIC and Market) • About 68 decentralized plants <p>Dry Waste Recycling:</p> <ul style="list-style-type: none"> • 1 MRF • 12 zonal sorting stations to facilitate segregation and transfer
--

Wet Waste Composting

For wet waste processing, CCP has 3 centralized composting sites and 68 decentralized sites with a total processing capacity of 12.5 TPD, as further described in Table 5.

Table 5 Wet Waste Processing Facilities' Capacity in Panaji, Goa

Waste Source	Capacity of the facility	Composting Sites
<ul style="list-style-type: none"> • 8 TPD of residential waste • 11 TPD of hotel/restaurant waste • 2 TPD of fish/slaughter waste 	5TPD	Heera
<ul style="list-style-type: none"> • 2.5 TPD of vegetable/ floriculture waste 	3 TPD	LIC
<ul style="list-style-type: none"> • 3 TPD of vegetable/floriculture waste 	3 TPD	Market Site
<ul style="list-style-type: none"> • 1.5 TPD of residential (household) waste 	1.5 TPD	Decentralized units (Community composting)

The centralized market composting facility located at the Panaji Municipal Market is spread over an area of 650 sqm and has 2 organic waste converters (OWCs) and 24 box composting units. Pit composting methodology is also used at this site, including the use of inoculum to accelerate the composting process and control odour. The site also maintains a register to record all incoming waste.

Additionally, CCP sends the oversupply of organic waste collected in Panaji to the Goa Waste Management Corporation Plant at Saligao.

Dry Waste Recycling

In the city, there are twelve zonal-level segregation sites (one in each zone) where all collected dry waste is initially aggregated. At these zonal locations, dry waste from households and other sources is separated for further processing. It is then transported to the Heera facility for weighing before being transported to the MRF in St. Inez, which has a capacity of 7 TPD. The dry waste is then separated into 20 different streams at the MRF. All recyclable material collected (approximately 3 TPD) is then auctioned off to on-site vendors, while combustible non-recyclable waste (4 TPD) is transferred to cement plants in Karnataka for co-processing. The selling of recyclables generated approximately INR 50,000 in revenue

in 2018. The MRF in St. Inez also has Thermocol (polystyrene) shredding equipment in place.

Saligao Treatment Plant

This integrated solid waste management plant at Saligao managed by GWMC uses the mechanical biological treatment (MBT) process and is capable of treating 100 tonnes of waste per day. Proper segregation, recovery of recyclables and the biomethanation technology is helping the plant generate surplus power. The facility is fully automated, except the manual sorting station where dry waste is further sub-categorised and baled for subsequent resale. At this facility close to 100% of the waste is segregated into wet and dry components using OREX technology. Non-recyclable waste is cleaned and baled, and sent to cement kilns to be used as high calorific value RDF for co-processing. Organic waste is sent for biomethanation at composting plants, while effluents are treated via Membrane Bio-Reactor(MBR)/Reverse Osmosis (RO) MBR/RO technology and recycled for domestic purposes. High calorific value RDF (> 4500 Kcal/kg) is sent to ACC Cement factory in Wadi, Karnataka and JK Super, and remaining inert waste (less than 3%) is sent to C&D plant as Panaji is a Zero Landfill City. A key benefit of the Saligao Treatment Plant is the low demand for land, and the fixed amount of land it takes up (compared with landfills which can expand); the plant's design took into account projected waste generation rates for the next 30 years.

Disposal

Since the Government of Goa implemented the Zero Waste and Zero Landfill philosophy, CCP has launched a "Shop-With-Your-Waste" campaign to further engage the people of Goa.

Shop-With-Your-Waste (SWYW)

Under the waste NAMA (Nationally Appropriate Mitigation Action) initiative, CCP established the 'Shop With Your Waste (SWYW)' method with cooperation from GIZ, a German Development Corporation, and The Energy Resources Institute (TERI). This one-of-a-kind programme not only opens opportunities for citizen engagement in waste management, but also has the potential to generate economic prospects for businesses with space to trade in recyclable commodities.

Under this campaign, registered shops will be permitted to trade PET bottles (clean, crushed and dried), cardboard (flattened) and milk pouches (clean and dry) through a barter system for household items like groceries, electronics, medicine, and fabric. Waste items have to be brought in a minimum quantity displayed at the shop. The shops taking recyclable waste from generators will eventually be linked with a large-scale waste dealer within Panaji, Ayya Waste Management, who will buy the recyclables from them.

The approach was launched in 2020. The COVID-19 pandemic did put a hold on the initiative and now again the campaign is gaining momentum with more stores joining the CCP to accept recyclable waste in exchange for grocery items. In the year 2022, from June to November, the SWYW approach collected 635.7 kg of waste. Table 7 depicts the types of waste collected during the period of June to November 2022.

5.3 Surat

Surat, also known as the "Diamond City," is one of India's largest urban economies, with \$59.8 billion in GDP. In 2011, the city had a population of 4.6 million people and a population density of 13,680 people per km² (Census of India, 2011). Surat is home to major industry players such as Reliance, Gas Authority Of India Ltd. (GAIL), Oil and Natural Gas Corporation (ONGC), Essar, Ultratech Cement, and Ambuja Cement. The city's diamond-cutting and polishing exports account for roughly 90% of total global exports, according to a report published by the World Economic Forum and PWC. Surat Urban Development Authority (SUDA) manages the industrial hub in Hazira, which is located on the periphery of Surat. The city has also been chosen for upgrades in various sectors such as IT, renewable energy, solid waste management, and town planning and development under the 'Smart City Mission' launched by the national Ministry of Housing and Urban Affairs (MoHUA).

5.3.1. Solid Waste Management in Surat

The much-needed focus on the different aspects of solid waste management in India started after the infamous plague outbreak in Surat in 1994. With a focused policy approach and other initiatives such as community participation, night cleaning, and regular garbage collection, the city became one of the cleanest cities in the country. This transformation was possible largely because of the Surat Municipal Corporation (SMC), the authorized body in charge of managing municipal solid waste in Surat, and the efforts of the community. The city is divided into seven zones and thirty administrative wards. The SMC reported that the city generates 2200 MT of municipal solid waste per day, of which 2150 MT is collected and transported on average.²⁷

The majority of the waste (~52%) produced in Surat is biodegradable waste. Figure 11 depicts the composition of MSW in Surat.

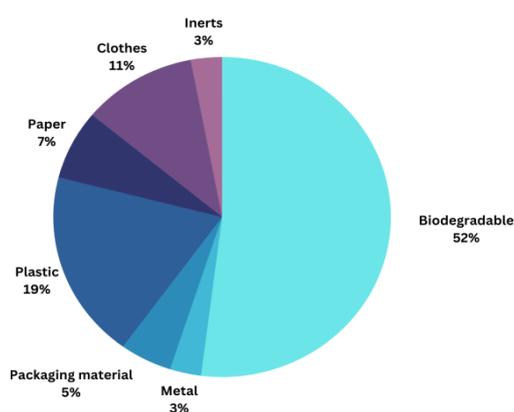


Figure 11 The composition of MSW in Surat
(Source: Waste-Wise-Cities, CSE, 2021)

²⁷Surat Waste Management Plan. (2021). [online] Available at: <https://www.suratmunicipal.gov.in/Content/Documents/rtiact/Disclosure/Solid%20Waste%20Management/main.pdf>

SMC establishes Public Health Bye-laws for the city, which include local regulations for solid and liquid waste management, air and noise pollution, and other sanitation and public health issues (SMC, 2016).

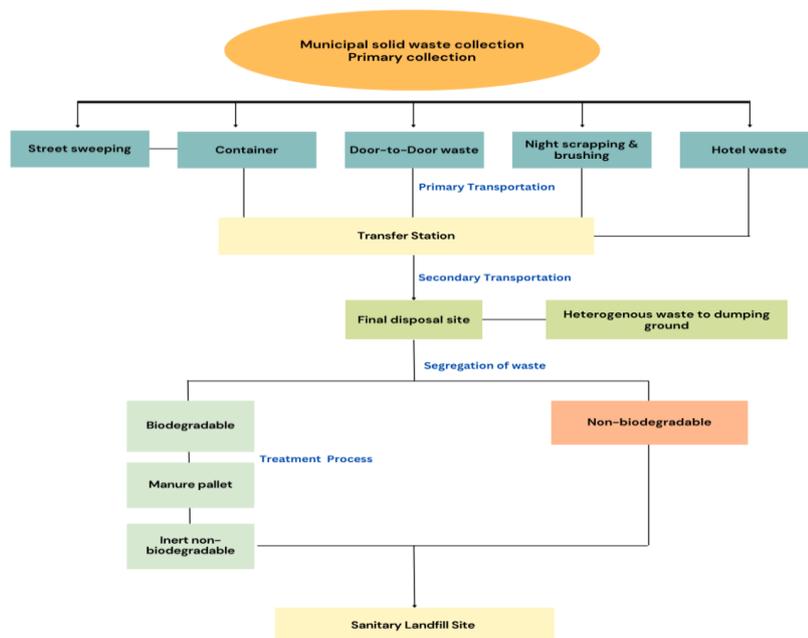


Figure 12 Flow diagram of the MSWM system adopted by SMC
(Source: Surat Municipal Corporation)

In April 2004, Surat implemented the door-to-door collection (DTDC) system. The DTDC system attempts to create “zero container” cities. The activity of primary garbage collection from the source of generation via the DTDC system is outsourced in part and carried out in part by the department. The activity of secondary transportation is also outsourced. The five separate organisations undertaking DTDC in eight zones are Om Swachatha Corporation, Global Waste Management Cell Pvt. Ltd., Western Imaginary Transcon Pvt. Ltd, Swachatha Corporation, and M/s Jigar Transport Co.²⁸ Aside from the DTDC programme, SMC has awarded contracts to private agencies for a variety of specialised services such as dead animal removal and biomedical waste collection and disposal.

5.3.2. Collection, Segregation, and Transportation

SMC has made street sweeping and waste collection a point of pride. Two main practices that contribute to greater efficiency are emphasized by the SMC staff. First, each area is cleaned at least once every 24 hours in either morning or at night. No other cities in India currently perform night-time street sweeping. Main roads, markets, and public places are cleaned during the night. Secondly, SMC has also installed 75 modern underground waste

²⁸Surat Municipal Corporation. (n.d.). SolidWasteManagementApproaches. [online] Available at: <https://www.suratmunicipal.gov.in/Departments/SolidWasteManagementApproaches>

collection dustbins in the South-East and East Zones, which collect ~ 40.35MT / Day of MSW.²⁹

The Anudan Scheme³⁰ was launched for people living in urban areas in order to maintain sanitation levels and give the best coverage of SWM services as required by the MSW Rules in peri-urban regions; (see text box below for more information).

Anudan Scheme:

The Anudan scheme was initiated by the authorities of the Municipal Corporation to prioritise community participation in cleaning and garbage collection. For maintaining cleanliness, residential and non-residential societies are charged 60 paise and 65 paise per square metre respectively. The minimum monthly payment to the society is Rs.1,200/-. The scheme requires societies to provide their own sweepers and sanitary equipment, while the SMC pays for consumable items such as insecticides. The societies must enter into a contract with the SMC to provide regular waste management services in their designated areas. Payments to the societies are made on a monthly basis based on the submission of a completion certificate signed by the president of the society. This scheme is currently benefiting over 600 societies.

SMC has established eight plastic waste collection points. To date, the collection facility has processed 28,000 tonnes of plastic waste. The processing plant has a current capacity of 75 TPD, with the possibility of extending to 200 TPD in the future to take into consideration growth in population and waste generation. Surat provides bins for waste segregation into dry (blue bin), wet (green bin), and hazardous waste (red bin). Even though the city has achieved 100% segregation benchmark,³¹ Surat is initiating new campaigns such as the Surati Segregation to keep up with this efficiency level. Surati Segregation addresses the waste segregation problem in residential societies.

Surati Segregation:

AIC SURATi LAB, in collaboration with NPO Innovate 4 India and the Surat Municipal Corporation, launched the "Surati Segregation," a three-month waste segregation challenge. Residents in this challenge learned how to separate wet, dry, and hazardous waste at their homes and were instructed to separate various wastes, such as diapers, before disposing of them in the door-to-door garbage vehicles.

Surati Segregation was a 13-week waste segregation challenge in which a pilot society was chosen and participants from the community were challenged to innovate and apply a unique solution that

²⁹ Surat Municipal Corporation. (n.d.). SolidWasteManagementApproaches. [online] Available at: <https://www.suratmunicipal.gov.in/Departments/SolidWasteManagementApproaches>

³⁰ Surat Solid Waste Management Project under Jawaharlal Nehru National Urban Renewal Mission City Report (2013). Available at:

<https://www.nswai.org/docs/City%20Report%20on%20Surat%20SWM%20Project%20under%20JNNURM.pdf>

³¹ WASTE-WISE CITIES Best practices in municipal solid waste management NITI Aayog. (2021). [online] Available at: <https://www.niti.gov.in/sites/default/files/2021-12/Waste-Wise-Cities.pdf>

would achieve 100% waste segregation in 100% of households with a team of at least 5 members. The best innovation was also awarded a prize of \$100,000. After achieving the goal, they will be eligible to claim the seed money, which enables the community to re-invest in their pilot project and scale it to become a profitable and self-sustaining venture that generates income from waste management.

Surat has eight transfer stations that are currently operating (Table 6). All primary waste collection trucks from door-to-door waste collection and sweeping arrive at the transfer station, where secondary transportation vehicles are filled with waste to be sent for disposal to the designated sites.

Samwedna Khushiyo no Pitaro:

Surat Municipal Corporation, through their initiative "Samwedna: Khushiyo no Pitaro," collects wearable clothes in good condition for men, women, and children in need, as well as toys and other necessities. Along with donation boxes, advance waste segregation bins for E-waste, small plastic bottles, and single use plastic bottles have been installed in each ward. Toys, clothes, books, money, and furniture can all be donated at these locations.

The project began during the Diwali festival (Indian festival). The SMC created a kit out of the items received and distributed it to those in need as Diwali gifts.

Table 6 Total Transfer Stations in Surat

Name of Transfer station	Zone
Bhatar	South west
Katargam	North & Central (Part)
Varachha	East
Anjana	South-East
Pal	West
Bhestan	South
Kosad	North-East-West
Dindoli	South-East

MSW that is collected using the primary collection system is sent to the semi-closed transfer station of the respective zone. From there the waste is mechanically compacted before being sent to the Khajod Disposal site via a closed container.

5.3.3. Processing and Treatment

SMC uses a combination of centralized and decentralized approaches to treat its biodegradable waste.

The SMC constructed a 400 TPD MSW processing plant in 2008 and has been under operation since September 2008. The plant is run by a private agency on the Build Own Operate and Transfer (BOOT) basis. The end-products from the plant are compost and RDF. The concessionaire has the rights to sell these products in the open market. The project has been registered as a UNFCCC Clean Development Mechanism (CDM), and the carbon credits generated will be divided among the stakeholders.

The SMC has planned a 600 TPD waste-to-energy unit to be built through a PPP. The facility will produce 8 MW of electricity from mixed waste provided by SMC, producing high-quality Syngas that will be utilised to generate power via the gasification process.

The SMC operates a centralised plastic waste management plant with a capacity of 20 TPD in collaboration with the agency, Eco Vision Resources L.L.P. The agency has developed and operates at least one collecting centre per zone. The agency has also collaborated with rag pickers and NGOs to collect plastic waste from the streets.

SMC has also granted a contract to M/s. Abellon Clean Energy Pvt. Ltd. for building a 1200 TPD Waste-to-RDF-to-Energy plant in accordance with the Gujarat Waste to Energy Policy. The plant will be built at Bamroli.

SMC plans to construct three decentralized organic waste processing plants on an Engineering Procurement & Construction (EPC) basis, each with a capacity of 20 TPD. The objective is to be ready for future challenges by managing various organic waste streams generated by hotels, restaurants, non-vegetable and vegetable municipal slaughterhouses, public and private cattle ranches, as well as market gardens.

5.3.4. Disposal

SMC had constructed a sanitary landfill at Khajod to handle rejects from waste treatment. The site was spread over 60 hectares and SMC stopped dumping waste there in 2014. The landfill site will undergo capping and an ecological park will be built there.

5.4 Varanasi

Varanasi, or Benaras (also known as Kashi), is one of the world's oldest living cities, located in the central Ganges Valley in North India. For almost 3000 years, the city has been a hub of learning and civilisation, and has also been a symbol of Hindu renaissance. The ghats of Varanasi are riverbank stairs that lead to the holy Ganges River. In the city, there are 88 ghats. The vast majority of the ghats are being used as bathing, puja, and cremation sites.

5.4.1. Solid Waste Management in Varanasi

The solid waste management of the city comes under the authority of the Varanasi Municipal Corporation (VMC). The city is divided into 5 zones, which are further divided into 100 wards. At a current waste generation rate of 0.58 kg/capita/day, the city of Varanasi generates about 748.75 TPD of MSW. Out of the total, about 567 TPD (76.9%) of MSW is collected from 90 wards in Varanasi, which is processed at respective processing facilities. On an average, about 283.03 TPD of wet waste is diverted for the composting facility at Karsada and 3.56 TPD is used at the three biomethanation plants in Varanasi. 25 TPD of waste is also diverted to the pilot waste-to-energy plant.

As a holy city, Varanasi generates a lot of waste from religious activities. Each day, waste material weighing 3.5-4 tonnes is left behind in the city, most of which is floral waste.³² Most

³²Yadav, S., Juneja, S., Chauhan, Yadav, I., Juneja, S. and Chauhan, S. (2015). Temple Waste Utilization and Management: A Review. [online] Available at: http://www.ijetsr.com/images/short_pdf/1442921490_14-19_ESM524_ijetsr.pdf

of the floral waste is recycled to make incense sticks. The majority of the waste produced (~51%) in Varanasi is biodegradable. Figure 13 depicts the composition of the city’s MSW.

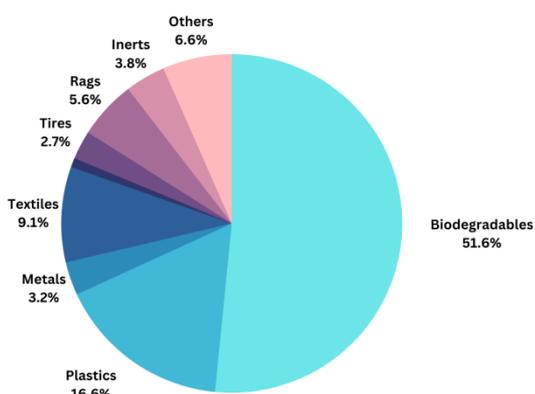


Figure 13 Composition of MSW in Varanasi
(Source: As-Is Assessment Report: Varanasi by TERI)

VMC has not adopted any bye-laws for the city regarding solid and liquid waste management, and other sanitation and public health issues. The city follows the guidelines published by the Uttar Pradesh Government titled, “Uttar Pradesh Solid Waste (Management, Handling and Sanitation) Rules, 2021.”

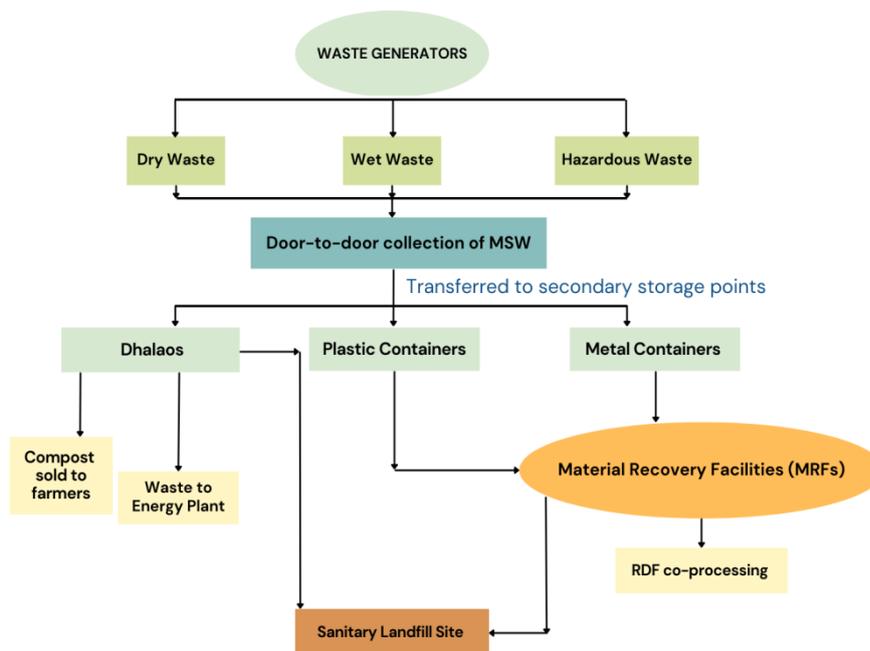


Figure 14 Flow diagram of the MSWM system adopted by VMC
(Source: As-Is Assessment Report: Varanasi by TERI)

5.4.2. Collection, Segregation, and Transportation

Door-to-door collection of MSW was initiated in December 2016. This results in a daily collection of waste from households, in addition to waste collected from activities like street

sweeping and an on-demand collection of C&D debris. The waste collected from households is transferred to secondary storage points (dhalaos), plastic containers (1.1 m³), and metal containers (2-5 m³ and >5 m³). While waste from roadside bins is collected by refuse compactors, a dumper or tipper truck is also used to collect and transport waste from secondary waste storage points to disposal sites or processing facilities. All the trucks travelling to and from transfer stations and processing facilities are installed with GPS tracking devices.

Varanasi Nagar Nigam (VNN) is currently carrying out DTDC and transportation of waste from 90 wards of the city. Furthermore, the wet waste collected from vegetable markets and hotels are sent to the three bimethanation plants run by ORSPL.

In Varanasi, the effectiveness of source segregation is 59%. The technique of source segregation involves informing waste generators to segregate dry, wet, and hazardous waste into three different coloured bins.

Continuous IEC campaigns on cleanliness and waste segregation at the source and on open defecation-free (ODF) zones are being carried out via public announcements with messages such as "throw your waste in your own dustbins separately." Swachhata Rallies are commonly held on topics such as cleanliness and waste segregation at the source, with an appeal to local residents to put their waste in dustbins rather than throwing it in the street, maintain cleanliness in their areas, and segregate green waste from dry waste.

5.4.3. Processing and Treatment

The waste received from various sources is sent to the two MRFs: Bhawania Pokhari MRF, under the supervision of O & M of M/s. TERI & M/s.GIZ India; and Aashapur MRF, under the supervision of O & M of M/s. Coca Cola & UNDP, where recyclables are separated from cumulative MSW. The waste from the MRFs is sent to either a centralized composting facility at Karsada, which has a capacity of 600 TPD, or 1 of the 3 decentralized waste management (DWM) bimethanation plants, each with a capacity 5 TPD.

VMC has adopted both a centralized and decentralized approach to handling biodegradable waste. VMC has installed a centralized composting plant at Karsada to produce compost out of the wet waste received at the plant. This plant was set up in 2010 under JNNURM for compost production using the windrow composting technique. IL&FS Environmental Infrastructure and Services Ltd. (ILFS Environment) has since undertaken the operation and maintenance of this plant, which receives waste collected from secondary waste collection sites in Varanasi. After segregation, the MSW is processed to produce about 75 TPD of compost and 100 TPD of RDF.

For the sale of RDF, an agreement between VMC, Indo-Gulf Fertilizers Ltd. (IGFL), and ILFS Environment has been signed. The compost produced is sold at a price of Rs 1000 per tonne to local farmers, and also being used by VMC and the Horticultural Department of Varanasi. The sale of compost provides for a subsidy of Rs 1500 per tonne once the compost is Fertilizer Control Order (FCO)- certified.

VMC has planned ten decentralized bimethanation plants, out of which three plants (each of 5 TPD) have been funded by the Indian Oil Corporation Limited (IOCL), located at Bhawaniya Pokhri, Pahadiya Mandi, and near the IDH Hospital in Varanasi. These WtE

plants also produce 20-30 kg of digested substrate per day, which passes through a screw press for dewatering and is subjected to solar drying to give high-quality organic fertilizer.

In Varanasi, as part of its CSR initiative, NTPC has outsourced the construction of a 200 kW pilot plant. This plant, which can process 25 tons of dry waste per day, will work on gasification technology to burn waste at about 800°C and use the producer gas to run engines. The provision of technology and O&M of the proposed plant is undertaken by Ankur Scientific Energy Technologies Pvt. Ltd.

RDF Co-processing

From September 2016 to April 2017, 2007 tonnes of Solid Combustible Fraction (SCF) were transported and pre-processed to RDF at the Kymore Integrated Facility and used as an alternative fuel at ACC cement plant.

Geocycle is a waste management solutions provider that turns waste into energy and recycled materials, and has advocated for the replication of the Wadi RDF facility in Karnataka.. The calorific value of RDF from this facility is high due to the addition of biomass.

As regards the financial considerations, some stakeholders such as SINTEF support cross-subsidization of RDF sale by levying user charges on waste generators so that transportation charges can be covered.

5.4.4. Disposal

In addition to the controlled dumpsite at Karsada, an old dump site is located in Ramana where 2.5 lakh metric tons of solid waste is dumped. This site has been capped as of now. Central Road Research Institute (CRRI) and National Highway Authority of India (NHAI) have been involved in utilizing the garbage dumped there in road construction around Varanasi.

5.5 Raebareli

Raebareli is a city in Uttar Pradesh, India. It serves as the administrative headquarters of the Raebareli district and is part of the Lucknow Division. The city covers an area of 43 sq. km. The city is situated on the banks of the Sai River. Raebareli had a population of 191,316 people in 2011 according to the census, with 35,197 households. Raebareli Nagar Palika is the authorized body in charge of waste management in the city, with the mission of making the town cleaner and more beautiful, as well as carrying out the duties outlined in the Municipal Act 1959 in order to provide better civic facilities and services to the citizens of the town.

5.5.1. Solid Waste Management in Raebareli

With urbanization, the population of Raebareli increased rapidly, along with waste generation. Raebareli Nagar Palika is the authorized body in charge of waste management in the city. The city is divided into two zones, which are further divided into 34 wards. Improper disposal of Palika solid waste leads to unclean circumstances, which can lead to contamination of the environment and epidemics of vector-borne illnesses, which are

diseases carried by rodents and insects.³³ The city generates 72 tonnes³⁴ of waste per day, 80% of which is generated from households, 15% from commercial establishments, 4% from industries, and 1% from construction and demolition activities. Currently, 40% of the waste is being collected in segregated form by Raebareli Municipal Council, and is being sent to Jaitpur plant for further processing.

5.5.2. Collection, Segregation, and Transportation

Raebareli Municipal Council has hired an agency named Prithvi Agro Farm Producer Company Limited to take care of the collection, segregation, and transportation of MSW generated in its area of jurisdiction. Sanitation is an essential component of their services as an Urban Local Body (ULB). As a result, for adequate public health, Raebareli Municipal Council also ensures proper cleanliness and sanitation in its municipal territory by removing and dumping any sort of solid waste generated within its municipal authority on a daily basis with the help of 167 female and 390 male waste workers. Apart from this Raebareli Municipal Council has undertaken an initiative to integrate informal sector waste workers working in the waste management domain. The ULB identified 25 informal workers who were residents of Raebareli and worked to improve their working conditions by providing training on types of recyclable waste, use and provision of personal protective equipment, associated hazards, and health risks. After the capacity building, they were provided ID Cards from ULB and were given the list of registered recyclers, where they were instructed to bring the waste they collect.

5.5.3. Processing and Treatment

Processing and treatment of MSW was being done in the city until 2022. As of now, dry waste is being sent to recyclers and wet waste is being sent for composting in the designated sites in different locations within the city. The Jaitupur processing and treatment plant is being updated to account for waste generation, while the remediation of the sanitary landfill in Jaitupur, which has already reached its capacity, is underway. Additionally, the ULB is coming up with a centralized composting plant for the treatment of organic waste. Raebareli Municipal council is also setting up an MRF in the Jaitupur site for further segregating their waste.

5.5.4. Disposal

For the last year, the waste from containers is collected by trucks and lorries and sent to a treatment plant near the Jaitupur police station. The city has a solid waste treatment plant owned by Acard Hydro Air Pvt Ltd on a 90-year contract that began in 2010. The treatment facility has a capacity of 70 MT per day and converts trash into fertilizers.

³³nppraebareli.in. Official Website of Nagar Palika Parishad, Raebareli, Uttar Pradesh. [online] Available at: <https://nppraebareli.in/een/page.php?id=47>

³⁴nppraebareli.in. Official Website of Nagar Palika Parishad, Raebareli, Uttar Pradesh. [online] Available at: <https://nppraebareli.in/een/page.php?id=47>

6 Best Practices

6.1 Indore: The Cleanest City in India

Indore is the largest and most populated city in Madhya Pradesh. It is also the largest metropolitan city in Central India. Indore's waste management system used to be unorganized, with littering, garbage vulnerable points (GVPs)³⁵, and stray animals and flies swarming around the littered sites. With constant waste management efforts, the city has not only made it to the list of clean cities but has topped it: in 2022 Indore was named the cleanest city in the country for the sixth time in a row.

The processing of 1,900 tons of urban waste every day earns the city crores of rupees and supplies fuels to be used for different sources. Awareness generation, door-to-door collection, source segregation of dry waste from wet waste, making compost from the waste products, removing garbage bins, and discouraging the use of polythene were some of the key initiatives taken by the Indore Municipal Corporation (IMC) to earn the distinction of cleanest city.

Highlights of the Initiative

Cooperation of NGOs and private Enterprises in Integration of Informal Waste Sector

IMC and two NGOs, Sarthak and Basix, collaborated to help integrate the informal sector with the formal sector. The recyclable waste + segregated by informal workers is sold to either the recycling industry or to companies that use recycled material.

Technological Upgrades

IMC deployed vehicles with 3.3 cubic metre capacities, which can cover approximately 1,000 households. The rest of the country uses garbage collection vehicles with 1.8 cubic metre capacities that can only collect waste from approximately 300 houses.

New Uses for Waste

Non-recyclable waste is sent to a cement plant in Neemuch and then to the M.P. Rural Road Development Corporation for use in road construction. Construction waste is sent to a separate privately run facility, where it is ground to various sizes and used as raw material for making bricks, paver tiles, and material to edge footpaths, all of which are procured by the government for its National Rural Employment Guarantee Act of 2005 (NREGA) and other public works programmes.

Landfill Management & Remediation

The major waste processing facility was constructed on the site of Indore's largest dumping ground. The municipal corporation rented machines in 2018 to separate the 'legacy' waste and clean up the facility. A portion of this reclaimed dumping site has been planted with trees and is being transformed into a park.

Innovative Measures to Build Cultural Attitudes

With proper awareness generation, people started carrying small dustbins in their cars so that they don't throw their wastes on streets. People also started carrying out cleaning work after every community event. An eighth pledge was added in the wedding rituals, with newlyweds committing to an oath of cleanliness. Dustbins were also distributed during wedding ceremonies in Indore.

³⁵ Garbage vulnerable points (GVP) refer to locations where garbage accumulates due to frequent disposal by local residents, travelers, or those passing by.

Fines for Littering and Rewards for Good Practices

IMC honors those who display exemplary initiative in tackling waste in their neighborhood, offering them a one-on-one meeting with the Mayor or the Corporation Commissioner. Additionally, a discount of 5-10% on property tax is available to those who install bulk waste convertors to compost organic waste in their premises. Litterbugs invite a hefty fine for non-compliance, and user charges have been levied for all occasions, even for rallies.

Decentralized Waste Management

Indore plans to decentralise waste processing in the street food and vegetable markets. Swaha (a solid waste management firm) gathers approximately 8 to 10 tonnes of biodegradable waste each day across Indore. All restaurants segregate their food waste and transport it to the Chappan Dukaan (an organic waste collection centre). Following the initial composting in the mobile van, the compressed waste is transported to another facility for further processing.

Converting Waste to Fuel

Waste to Energy Solutions Ltd Company has a 15-year contract with IMC to operate the biomethanation plant. Every day, around 20 tonnes of waste is collected and transformed into 750-800 kg of bio-compressed natural gas (bioCNG). The gas produced is used to power city buses and is supplied at a subsidised rate as cooking fuel to hotels and the Indian Institute of Management.

Programme Sustainability With a Robust Financial Model

The Indore approach is very expensive from a financial standpoint. Many cities do not receive funding for solid waste management and sanitation. However, Indore has a strong user fee collection system, significant penalty costs, and revenue from the sale of compost and dry waste, making it financially sustainable.

IMC spends approximately Rs 879 crore per year to run the waste management system. The city collects approximately Rs 27 crore in user fees per year, with property taxes covering the remaining expenses. Households pay up to Rs 60 per month for waste collection, while businesses pay up to Rs 150 per month. Businesses, offices, and other commercial properties pay Rs 3 for every kg of waste collected from them.

Outsourcing Cuts Costs

In this model Swaha collects about 8 to 10 tonnes of compostable waste daily; the Waste to Energy Solutions Ltd Company has a contract with the IMC to operate the biomethanation plant; and two NGOs, Sarthak and Basix, have collaborated with IMC to integrate the informal sector to sort waste. Through this outsourcing arrangement, the IMC saves both time and money as it does not have to concern itself with the mentioned aspects.

6.2 Maharashtra: Beed Swachhta Mission Organic Sahkari Samiti Model (BSMOSS)

BSMOSS is the replica of the Ambikapur model. The model works to tackle the issue of waste mismanagement in urban cities and districts of India. In the model ULB officials and political officials were given an introduction on how to design a sustainable model for proper waste management. Various government schemes such as Swachh Bharat Mission, National Livelihood, Digital India, Skill India, and Jaivik Bharat were involved in the model. Women led Self-help organizations (SHGs) were integrated with corporate society culture in the model which was

adopted from the concept of 'Lijjat papad' in Maharashtra and 'Amulya Doodh Cooperative Society' in Gujarat.

The cooperative society is made up of rag-pickers, underprivileged women and other unemployed people. Cooperative members are assigned duties at the ward level, including door-to-door waste collection, transportation of waste, micro-segregation, processing and selling of compost made from waste.

Highlights of the Initiative

Proper Support and Encouragement Of Workers

With support and encouragement from administrative bodies such as Gram Panchayat, Nagar Palika, Nagar Panchayat, and Municipal Corporation, this model has been successful in the city of Beed. Workers are well treated and respected by society.

Inclusion of Farmers in the Municipal Waste Management System

Farmers are also integrated into the cooperative society, because in Beed district 60% of the wet waste is bought by farmers. High-quality organic manure is prepared from the waste collected by the women-led SHGs and is sold to the farmers. BSMOSS has also planned to sell the fruits and vegetables produced by the farmers using the manure sold by them.

Stable Income Generation From Proper Management of Waste

The income collected from sale of organic manure, fruits and vegetables, dry waste, and user charges are used as the income for the cooperative society. In this way, the model is made sustainable.

Decentralized Management of Waste

To reduce garbage transportation costs and overall processing costs, the wards are divided into groups, with each group comprising 2 to 3 wards. A decentralized approach is used in the model to manage the waste that is collected from each group of wards. Solid and Liquid Resource Management (SLRM) Centers have also been deployed where further segregation of the collected waste takes place.

Community Participation

The women-led SHGs are members from the community itself. Underprivileged women and other unemployed people from the community and monitored directly by the community are more accountable and trusted than sanitary workers employed by the government. Engagement of self-help groups brought a sense of empowerment to the women involved in the waste management domain and helped them achieve dignified lives by becoming self-sufficient with proper training and stable income.

Inform, Educate, and Communicate

BSMOSS demonstrated how information, education, and communication (IEC) initiatives are critical for raising awareness and fostering public opinion and involvement. This has been supplemented by regular follow-ups by SHG members to communities and identification of households refusing to participate in the initiative.

Informal workers were also trained in this model very well. Hand-holding of the informal workers is the most important task in the waste domain and has been successfully done in the Beed Model. A good relationship is developed among each informal sector. Interpersonal skills were also developed to integrate the informal workers into a society.

6.3 Surat: From Garbage-Littered City to the Second Cleanest City in the Country

Following the breakout of the plague in 1994, the SMC learned the consequences of poor solid waste management. However, in just 18 months, the SMC, with the aid of the community, transformed itself to one of the cleanest in the country.

Highlights of the Initiative:

Awareness is the key

With Surat-Khubsurat, an awareness generation campaign, SMC encouraged citizens to actively participate in the transformation of the city to one of the cleanest cities in the country. Several initiatives to bring significant behavioural change to promote cleanliness and hygiene in their day-to-day lives were launched. Other schemes such as Anudan scheme was also launched as part of awareness generation regarding sustainable waste management.

Night Scraping & Brushing Activity

Surat is the only city in the country where night cleaning of roads is done. The Surat civic body employs 2,190 workers for cleaning during the night time. This also generates a source of employment to the unemployed people in the city. The city collects around 6 to 24 MT/Day of MSW via the night scraping & brushing activity. As part of the Swachh Bharat Abhiyan, night sweeping drives are also conducted by the SMC.

Institutional Changes

Six zones were created to distribute responsibility for all official tasks throughout the city. Each zone was assigned a commissioner with additional authority. Every day, personnel in charge of solid waste management were required to make field visits. People were given grievance redressal cards so that their complaints could be registered. The issue was handled within 24 hours, and the citizen's card was returned.

Penalties Imposed

The government set a penalty to make citizens aware of their responsibilities to keep their city clean. Every littering offence resulted in Rs 50 fine, which was doubled for each successive offence.

6.4 Kerala: Haritha Karma Sena

Haritha Kerala Mission was established under Nava Kerala Mission and Suchitwa Mission to continuously support local bodies in the waste management sector. The local government bodies deployed the "Haritha Karma Sena", a women-run self-help group, for periodic collection of non-biodegradable waste from houses and establishments. Haritha Karma Sena, the green task force of every local body, is an integral part of the waste management system in the State. Kerala has a strong women-based community organization called 'Kudumbashree'. The Haritha Karma Sena comprises of Kudumbashree members who collect non-biodegradable waste from homes and commercial establishments for recycling. People who do not have dumpsters in their homes bring their biodegradable waste to the community aerobic bins. The Sena categorizes waste into distinct groups based on its characteristics. Haritha Karma Sena members are involved in the production of environmentally-friendly products, the maintenance of waste disposal systems, organic farming, the rental of environmentally friendly equipment, the production of compost, and other related activities.

In Kerala, Haritha Karma Sena has done a remarkable job in transforming municipalities like Taliparamba, Vadagara, and Alapuzha into places that are modeling best practices in municipal solid waste management.

Highlights of the Initiative

Building a Strong Socio-Political-Economic System

Community sensitization programmes with proper support from local bodies are an integral component of waste management programmes. In Kerala, the community network system called Kudumbasree, government organizations, and other institutions are very strong and supportive, which is the key reason for the success of Haritha Karma Sena's work. Community-based participatory models are necessary to implement such models successfully.

Support From the Authoritative Bodies

The Haritha Karma Sena originated under the leadership and guidance of the local government. The local bodies ensure that user fees are being collected properly and support is provided to them wherever they face the problems of social acceptance. The local bodies can also provide gap funds to ensure the sustainability of Haritha Karma Sena.

Creating Awareness for User-Fee Collection

Haritha Karma Sena collects user fees from individual households as well as from commercial establishments. The revenue of the sena members is determined by the amount of non-biodegradable and degradable waste collected by the sena each month from the doorsteps of households and commercial establishments within each local body. For instance, in Vadakara municipality each member of the sena gets an income of INR 15000 per month. Under this model, user fees are collected to form the income of the sena members. The Haritha Kerala Mission was started in 2016 and still the team faces challenges regarding this matter. As a solution to this problem, the local bodies ensure that user fees are being collected properly. As a part of awareness generation on user-fee collection KarshakaMithra released videos on Haritha Karma Sena explaining the working methods of Haritha Karma Sena and their importance. The same video also tells about why user-fee charges are being collected and that the charges have been allotted as per the waste management rules.

Involving the Informal Sector

The SHGs participating in this concept were members from the community itself. This made it easier for sena members to operate inside the community because such SHGs had considerably greater access to families because locals trust them. Workers seem to be more encouraged to complete the project since it benefits their life. It is also a step toward poverty eradication since it allows the most vulnerable members of the community to find lucrative employment in waste management.

New Uses for Waste

As per the Haritha Karma Mission, shredded plastic is being given to local bodies for road tarring by Clean Kerala Company Ltd. So far 2,800 tonnes of plastic waste has been in the construction of

4,967.31 km of roads.³⁶

Art from Waste

Businesses promoting value-added products from waste such as purses, toys, clothes, bags, etc., have been created. St. Teresa's College in Kerala has a club which is engaged in this and they train Haritha Karma Sena members for the same.

6.5 Panaji: Zero Waste, Zero Landfill Model

In Panaji, before a waste management programme and measures were put in place, waste disposal contributed to the spread of infectious and non-communicable diseases, affecting the local population's welfare, livelihood, and economic productivity. The leachates polluted the groundwater by contaminating the soil. With no other options, the Corporation of the City of Panaji (CCP) sought more scientific and inventive solutions.

The solid waste management programme of Panaji City, which manages waste segregation, sorting, and recycling, has been effective because the CCP has worked persistently over the last 15 years to improve processes and also include locals in its initiatives. Currently, there is no sanitary landfill. Waste is disposed of at need-based temporary waste disposal sites. Panaji was intended to be Goa's first landfill- and bin-free city.

Highlights of the initiative

Segregation at Source

CCP initiated door-to-door-collection (DTDC) of segregated waste in the year 2003 and hence has established a robust waste source segregation mechanism. In a bid to overcome land constraints including the lack of a sanitary landfill site, CCP strives towards maintaining a bin-and-landfill-free city. To help achieve this goal, it adopts the 3R paradigm and has enforced source segregation among all categories of waste generators in its jurisdiction. CCP follows 16-way segregation of different waste streams. Because of 16 streams of segregation, the task of managing non-biodegradable waste at the material recovery facility (MRF) has been reduced. CCP has a system comprising three centralized and about 68 decentralized composting facilities to process the segregated wet waste that is generated across the city. There are 12 zonal-level segregation points in the city (one in each zone), where all the collected dry waste is first aggregated. It is then sent to the Heera site for weighing, and from there it is then sent to the MRF at St. Inez. All the salvaged recyclable material (about three TPD) is then auctioned to the vendors at the site itself.

IEC Activities

As part of creating awareness, CCP launched the "I Can Change My City" app, which works as a bridge between communities and the Corporation and reduces the gap between them. Mural paintings, and initiatives such as the campaign SeetiBajao, City Bachao, in which volunteers blew whistles every time they saw anyone littering, received a huge response during the International

[Correspondent, S. \(2022\). 2,800 tonnes of shredded plastic used in road construction in Kerala. The Hindu. \[online\] 22 Apr. Available at: https://www.thehindu.com/news/national/kerala/2800-tonnes-of-shredded-plastic-used-in-road-construction-in-kerala/article65345432.ece](https://www.thehindu.com/news/national/kerala/2800-tonnes-of-shredded-plastic-used-in-road-construction-in-kerala/article65345432.ece)

³⁶

Film Festival (IFFI).

Expenditure Flow

According to CCP, approximately Rs 7 lakh is collected as property tax each year for sanitation, and Rs 9 lakh is produced via compost sales. Operators receive Rs 10 lakh per year from the sale of recyclables and refuse-derived fuel (RDF). CCP processes waste and ships around 250 to 300 tonnes per month of refuse-derived fuel (RDF) to Karnataka. The selling of recyclable materials helps in generating the Corporation around Rs 1 lakh per month.

Reduction in the Use of Natural Resources

The utilisation of non-recyclable waste by cement industries directly contributes to the reduction of fossil fuels usage.

Introduction of Technologies

Leachate tanks collect leachate from waste in segregated waste collecting vehicles. The vehicles contain a hydraulic mechanism that allows two dustbins to be held together and waste to be dropped inside the vehicle without the need for any labour.

CCP has devised digital waste bins that separate paper, metal, glass, mobile batteries, and plastic for Panaji streets. When the bin's button changes from green to red, an alert is sent to CCP, sending the command to empty the bin.

7 Findings & Recommendations

The Government of India's SBM, AMRUT, and Smart Cities programs made significant advances in solid waste management. Nonetheless, some major Indian cities are facing issues with littering, landfill legacy waste, dumpsites, and open waste burning. This poses a significant public health and environmental risk. Dependency on landfill and dumpsites must be reduced and with that, more efforts to divert waste from the landfill have to be undertaken, rather than trying to treat the waste after already reaching the dumping ground.

This section identifies key gaps where further research is required to understand the challenges that ULBs face in managing municipal solid waste. As per the gap assessment conducted from discussions held throughout the ten workshops organised for the five selected cities, a self-sustaining waste management model is required that focuses on the top levels of the waste management hierarchy and is self-regulating with the involvement and participation of all the stakeholders. The key gaps, findings, and recommendations for ULBs are discussed below.

7.1 Key Findings and Identified Gaps

1. Challenges in Connecting National Policies with Local Rules and Bye-laws

There is a lack of awareness regarding the various provisions of EPR rules and its enforcement at municipal level along with the various stakeholders. PIBOs, one of the key stakeholders, are responsible for facilitating the collection and management of waste generated by producers and ensuring compliance with the EPR rules. However, they also have concerns regarding offsetting of EPR liabilities.



Interpreting various amendments to the SWM Rules, 2016 at the city-level is also challenging for the ULBs. Each amendment requires ULBs to prepare a plan for the management of solid waste and implement it in their jurisdiction. By the time ULBs incorporate the amendments into their bye-laws, the new amendments are adopted by the central government. This can pose a challenge for ULBs, as they may need more time to modify their existing plans and systems to comply with the latest amendments.

ULBs are not aware of how much flexibility the local government should have when crafting its bye-laws in light of national rules. For instance, an area of ambiguity for ULBs is the rules that can be included in a city level bye-laws expressly for Low Value Plastics (LVPs) to increase its collection and processing. Urban municipal authorities struggle to manage low-value plastics because they have no market value.

2. Challenges in Managing Plastic Waste

Plastic waste management brings a unique cross-cutting opportunity to contribute toward 14 of the 17 Sustainable Development Goals (SDGs). Stakeholders across the plastic value chain face various challenges such as: (i) lack of technical understanding on how to track and manage single-use plastic (SUP) waste effectively; (ii) lack of understanding of alternatives for SUPs; and (iii) low public participation or lack of social innovation and social engineering.



In addition, the management of packaging waste is a significant challenge for ULBs. As the majority of plastic waste is generated from discarded packaging, ULBs are seeking ways to improve collection and processing of low-value plastics (LVPs) as well as trying to understand how to increase the market value for LVPs (including multilayered plastics) to boost collection rates.

3. Challenges in Setting Up Necessary Facilities for Waste Management

MSWM and the adoption of processing technologies are determined by the quantification and characterization of total waste generated in a locality, the available monetary resources, the availability of suitable land, and the local authority's in-house capabilities to monitor project execution. ULBs are finding it difficult to implement most of the necessary facilities due to lack of available land, lack of willingness of private companies to participate in the waste sector, lack of awareness regarding the use of RDF technologies, or the scale of technology that needs to be considered for the design of a dumpsite.



4. Challenges in Validating the Efforts of Informal Waste Workers

Despite the essential role of the informal sector in waste collection and diversion from landfill, ULBs have found it difficult to officially integrate informal waste workers into waste management programmes, citing budgetary restrictions and workers being migrants from other countries like Bangladesh in search of jobs and livelihood, as the two major barriers. In addition to not being formalized, informal waste workers often lack access to basic social welfare benefits, programs, and services. Research on the contributions of the informal sector to formal waste management systems, the social and economic repercussions of informal waste management systems in India, and on gender equality and inclusivity issues within the informal (and also formal) sector is lacking. Study of the specificities of women and men's needs, roles, and vulnerabilities within the sector, as well as previous initiatives implemented for their protection is needed.



5. Challenges in Setting Up a Viable Business Model

A lack of viable business models for waste management is a major barrier to improving waste management in India. ULBs lack a self-sustaining revenue generating model through the provision of various waste management and disposal services and recycling solutions. Sustained revenue generation requires support from all the stakeholders in the sector and can potentially be generated from user-fee collection, sale of dry waste, manure selling, and sale of RDF, among other methods. However, some measures like the implementation of doorstep user-fee collection typically face a lot of resistance from the local communities. Additionally the lack of proper segregation of waste affects the quality of sellable material for recycling and reuse, thereby affecting selling prices. ULBs, therefore, need to identify suitable business models that are relevant and applicable to context.



7.2 Recommendations

1: Connecting National Policies with Local Rules and Bye-laws

- **ULBs shall update local waste management bye-laws to incorporate amendments introduced by the central government in a timely manner.**

The integration of national and state provisions into city-level bye-laws will help ensure that relevant rules get adopted by society at the city level. The corporations and states will not be at liberty to change the moratoriums at the national level, but if the moratoriums become a part of city bye-law, they can also be used to penalize individuals and companies that do not observe the rules. Hence, amending bye-laws is a necessary step for a city's sound waste management.

The flexibility the municipal corporations have in terms of designing their bye-laws is something that needs to be understood. This could be done by critically analyzing the key priorities and challenges to waste management in the city and adopting laws that go beyond the central and state government rules. There are certain provisions that cannot be standardized in terms of user charges and fines. In this regard, the city government can make decisions as per the city's demographics. For instance, at the national level, bulk waste generators are defined as "buildings occupied by the Central Government Departments or Undertakings, State Government Departments or Undertakings, Local Bodies, Public Sector Undertakings or Private Companies, Hospitals, Nursing Homes, Schools, Colleges, Universities, other Educational Institutions, Hostels, Hotels, Commercial Establishments, Markets, Places of Worship, Stadia and Sports Complexes etc. having an average waste generation rate exceeding 100 kg per day (of all waste streams put together)". However, Panaji, a very small city in Goa, defines bulk waste generators in their bye-laws as "any unit having an average wet waste generation rate exceeding 25 kilograms per day or 1000 kilograms of garden or horticulture waste per month." For all cities to update their bye-laws according to amendments by the national government, the government should also provide ULBs with sufficient time to develop the bye-laws incorporating the recent amendments and implement them on ground. Each amendment to the National provision requires ULBs to prepare a plan for the management of solid waste and implement it in their jurisdiction. By the time ULBs incorporate the amendments into their bye-laws, new amendments are adopted by the central government. This situation can pose a challenge for ULBs, as they may need to modify their existing plans and systems to comply with the latest amendments. It can also lead to delays in the implementation of the latest amendments and affect the overall effectiveness of the solid waste management framework. The clause 5c of SWM, Rules 2016, mentions that all cities shall prepare their own bye-laws in order to develop laws tailored to the needs of the region.

- **To review and improve implementation of Extended Producer Responsibility (EPR) at city level and the integration of the informal sector within the framework.**

While Extended Producer Responsibility (EPR) for plastic waste management was introduced as early as 2011 in the Plastic Waste Management Rules, the implementation

framework for EPR has been strengthened in recent years. The EPR registration portal is now operational on the Central Pollution Control Board (CPCB) website and the major producers of plastic packaging, importers and brand owners (PIBOs) are in the process of registering on it along with plastic waste processors. PIBOs have been given targets for collection of plastic waste against the volume of plastic packaging they put in the market, and recycling certificates are issued by plastic waste processors to monitor actual recycling. EPR implementation however is still focused on end-of-life waste management and has very little focus on waste reduction strategies.

Some of the advantages that the EPR system can bring at the city-level are the creation of infrastructure for collection and recycling of material, and reduction in waste disposal costs for ULBs³⁷. This can be facilitated through appropriate public-private partnerships with relevant industry stakeholders, which plays an important role in supporting capacity building for ULBs. Local bodies that have limited understanding on how such partnerships can contribute towards driving EPR should leverage the expertise of enterprises such as Shakti India Foundation, Sampurn(e)arth Environment Solutions Pvt. Ltd, and Dalmia Polypro IndsPvt. Ltd., that provide EPR services to ULBs and PIBOs.

Sampurn(e)arth Environment Solutions Pvt. Ltd

Sampurn(e)arth Environment Solutions Pvt. Ltd is a social enterprise working towards providing end-to-end solid waste management solutions which are environmentally sustainable, by actively engaging waste pickers and the informal sector. Sampurn(e)arth Environment Solutions Pvt. Ltd has prominent EPR clients such as Tetrapack, Unilever, Coca-Cola, and UNDP. In Bicholim, Goa, Sampurn(e)arth along with UNDP operates the MRF in Bicholim. There are no financial repercussions for the BMC because the MRF is exclusively operated by Sampurn(e)arth Environment Solutions. BMC has no financial responsibilities other than the expense of transporting non-biodegradable waste to the MRF. Hence, this case study also shows that outsourcing creates a win-win situation for all the stakeholders in the sector. Sampurn(e)arth has made the initiative financially viable in Bicholim by improving it with enhanced collection, segregation, and disposal, as well as emphasizing on collecting valuable goods while recycling waste.

The informal sector plays a major role in supporting cities as they work to divert waste from landfills, recover valuable resources, increase supply of raw materials to the recycling facilities and reduce municipal waste handling and transportation cost. However, the recent amendment of EPR on 22nd February, 2022 fails to acknowledge the role of the informal sector. There are additional studies that illustrate how failing to engage the informal sector adequately in EPR systems may weaken their efficiency and efficacy.³⁸As a result, the link between the informal waste industry and the EPR must be strengthened. This can be accomplished by mandating the inclusion of the informal sector workforce as a minimum

³⁷ [SWACHH BHARAT MISSION MUNICIPAL SOLID WASTE MANAGEMENT MANUAL Part II: the manual. \(2016\). \[online\] Available at: https://mohua.gov.in/upload/uploadfiles/files/Part2.pdf.](https://mohua.gov.in/upload/uploadfiles/files/Part2.pdf)

³⁸ Organisation for Economic Co-operation and Development (OECD). (2015). Extended producer responsibility and the informal sector. [online] OECD iLibrary. Available at: [https://www.oecd-ilibrary.org/sites/9789264256385-9-en/index.html?itemId=/content/component/9789264256385-9-en.](https://www.oecd-ilibrary.org/sites/9789264256385-9-en/index.html?itemId=/content/component/9789264256385-9-en)

condition for waste management agency registration.³⁹ ULBs could also provide some space to the informal sector for the segregation of collected waste. There are agencies ready to build MRFs if ULBs provide enough space to them. Steps may also be taken to reserve a minimum percentage of personnel roles in collection centres and MRFs being established at the city-level for the informal sector.⁴⁰ These efforts will not only ensure that waste pickers are included in every waste management team, but will also give them a social identity and a steady source of income. Partnering with the informal sector will provide a win-win scenario for different organisations to benefit from the informal sector's experience while also providing training to enhance their skills on the same.⁴¹

Furthermore, successful implementation of the EPR mechanism will support the development of recycling units at the city-level, since recycling capacities will need to increase in tandem with improved waste segregation rates and PIBOs will require waste collectors to implement segregated waste collection.

2: Addressing plastic waste management challenges

- **Strict monitoring of single-use plastic phase-out must be paired with efficient ways to reduce the use of SUP packaging waste and other plastic litter. Further, analysing locally-available alternatives to plastics to reduce plastic consumption, must be explored.**

To curb plastic pollution at the national level, local-level implementation is required, which may be achieved through the implementation of bye-laws and developing comprehensive action plans.⁴² For instance, there are states that have gone beyond the central government's ban on single-use plastic items and have come up with more items to be incorporated in the list. Kerala has banned items such as non-woven bags, PET/PETE bottles of drinking water of capacities less than 500 ml, and PVC flex material,⁴³ due to the lack of recycling units and the unwillingness of the cement industry to accept such materials. These plastic materials are not banned at the central level but the Kerala Government has gone ahead and banned them as per their bye-laws.

Bye-laws should include provisions for enforcement and monitoring of initiatives such as plastic bans and SUP phase-out. As per rule 16 of PWM Rule, 2016 State Government or the Union Territory shall constitute a State Level Monitoring Committee for Effective

³⁹The Energy & Resources Institute. (2022). A link towards integrating informal sector may complete the EPR mechanism. [online] Available at: <https://www.teriin.org/article/link-towards-integrating-informal-sector-may-complete-epr-mechanism>

⁴⁰The Energy & Resources Institute. (2022). A link towards integrating informal sector may complete the EPR mechanism. [online] Available at: <https://www.teriin.org/article/link-towards-integrating-informal-sector-may-complete-epr-mechanism>

⁴¹The Energy & Resources Institute. (2022). A link towards integrating the informal sector may complete the EPR mechanism. [online] Available at: <https://www.teriin.org/article/link-towards-integrating-informal-sector-may-complete-epr-mechanism>

⁴²NITI AAYOG -UNDP HANDBOOK ON SUSTAINABLE URBAN PLASTIC WASTE MANAGEMENT. (2021). [online] Available at: https://www.niti.gov.in/sites/default/files/2021-10/Final_Handbook_PWM_10112021.pdf

⁴³pib.gov.in. (2022). Ban on single use plastics. [online] Available at: <https://pib.gov.in/PressReleasePage.aspx?PRID=1807646>.

Implementation of PWM Rules, 2016.⁴⁴ Such a task force shall be introduced at the city-level, and further, a plastic waste management unit could be developed that has a complaint portal/public grievance unit. For instance, Delhi has a state-level special task force that is responsible for checking illegal manufacture, distribution, sale and use of banned plastics. Delhi's comprehensive action plan (CAP) for eliminating selected single-use plastic in the city also includes identification of alternative products and its research and development, among others.

The most difficult stream of plastic waste to be managed by the urban local bodies is low-value/multi-layered plastics (MLPs), as it does not have any resale value. In most cities, the majority of plastic waste is MLPs such as tobacco sachets and candy wrappers, which are light, easy to throw, but difficult to collect. Collection of low-value plastic waste at the city-level can be improved through innovative decentralized plastic collection mechanisms like garbage cafes, grains in-exchange for plastic waste, and "shop with your waste". Initiatives like this need to be implemented at the city-level and linked with recycling companies that will make further products out of it. Bulk dispensing systems, refill systems, and crockery banks are also efficient ways to reduce the use of existing single-use plastic items. Additionally, the use of MLP as an alternate fuel in cement factories or in waste-to-energy (WTE) plants can potentially provide a solution for processing massive volumes of MLP on a daily basis.

There is also a need to look at local resources and identify what is available at the local level. With the introduction of locally-available alternatives, conventional SUPs such as plastic cutlery, plastic cups & lids and containers could be replaced. Non-plastic material replacements made from bio-based materials such as bamboo, banana leaves, wood, rice, and wheat bran, can replace plastics in products and packaging and reduce consumption of single-use plastics. Exploring and promoting locally available alternatives to plastic can not only help to address the issue of plastic waste but can also promote local industries and support sustainable livelihoods. To promote the use of alternatives along with awareness generation, government support and recognition of such potential alternatives is required. There are organizations such as Green Bug, EnviGreen, and Rimagined working on alternatives to plastic and promoting their procurement among consumers. For such organizations to rise to the top in consumer preferences, appropriate government support in the form of various incentives and initiatives is required. There are studies that mention that the key sustainability challenges for green businesses are the lack of funding, for which Viability Gap Funding (VGF) for developing alternatives need to be provided.^{45,46}

⁴⁴PROMOTION OF COUNTER MEASURES AGAINST MARINE PLASTIC LITTER IN SOUTH EAST ASIA AND INDIA REPORT Desktop Review of Plastics and Plastic Pollution.(2021). [online] Available at: <https://www.npcindia.gov.in/NPC/Uploads/file%20upload/Desktop%20Review%20of%20Plastic%20and%20plastic%20pollution.pdf>.

⁴⁵ White paper on circular economy by international trade promotion organisation, M. Visvesaraya Industrial Research and Development Centre (MVIRDC), World Trade Center Mumbai

⁴⁶ Zujewski, B. (2022). Overcoming the Top 5 Sustainability Challenges for Small Companies. [online] Green Business Bureau. Available at: <https://greenbusinessbureau.com/green-practices/overcoming-the-top-5-sustainability-challenges-to-small-business/>

3: Setting Up Necessary Facilities for Waste Management

- **Technology interventions can be identified by analysing the fundamental challenges in the waste management scenario and the local requirements of the city.**

Municipal corporations or their contracted operators must have waste management equipment that meets the criteria of their respective cities. Conscious customization and design of waste collection vehicles is required to fulfil local waste management needs more effectively. Smart waste management technologies can support the optimization of routes for waste collection, disposal, allocation of bins, and more. Route analysis with technologies like Geographic Information System (GIS), use of Internet of Things (IoT) designs such as smart dumpsters, and IoT-integrated Information and Communication Technology (ICT) tools in India are some emerging smart waste management solutions.

States like Andhra Pradesh and cities like Panaji and Indore, have upgraded their waste management technologies as per their local requirements and these practices have led to changes happening on the ground. For example, the Andhra Pradesh government launched a Real Time Monitoring System by integrating IoT and ICT tools. The system was launched in 89 ULBs. The Real Time Monitoring System supports micro planning with pinpoint details of gate-to-gate collection, collection routes, source segregation, measuring the weight of the waste before being loaded into trucks, and transfer points.

- **At a granular level, awareness generation is the key to achieving a sound waste management system in a city.**

In order to develop sustainable waste management systems, extensive awareness generation amongst citizens is required. In low- and middle-income societies of India, waste management is often still rudimentary. Garbage vulnerable points, littering, and open burning of waste are often encountered at such localities where waste collection services are sparse. Such situations can be reversed through public awareness raising. Indore, the cleanest Indian city, has an extensive awareness generation mechanism which includes innovative measures to build cultural attitudes, which are summed up in seven habit-changes as follows:

- **Everyday garbage disposal:** Daily door-to-door waste collection where waste is segregated into dry waste and wet waste.
- **Garbage to compost:** Organic waste transformed into compost and then sold to farmers and landscapers as fertilizer.
- **Discouraging use of polythene:** Strict enforcement on the prohibition of polythene use, whether for personal or commercial purposes.
- **Dustbin on wheels:** To prevent littering in public spaces, residents carry dustbins in their cars.
- **Awareness among children:** Students are educated about how unclean living spaces can negatively impact human health. They are encouraged to take responsibility for keeping their living areas clean and are also incentivized to do so.
- **Public and social functions:** After functions and/or events, residents are encouraged to make a conscious effort to clean up the space.
- **The Eighth Pledge:** As a part of their culture in Indore, couples committing to each other in a marriage take an additional oath (the eighth oath), known as the oath of cleanliness, which obligates them to be devoted to keeping their city and surroundings clean.

Awareness generation in the community should not be limited to the importance of waste segregation and proper disposal but should also include aspects such as the purpose of user-fee collection, as a way of generating sustained revenue for the waste management system. The income of Haritha Karma Sena in Kerala and the women of BSMOSS in Maharashtra depend on the user fee collection from houses and establishments within each local body, sale of organic manure, and the sale of dry waste. The members faced significant resistance in collecting user fees. As a solution to this problem, in Kerala, the Karshaka Mithra released a video explaining why user fee charges are being collected and that the charges have been allotted as per the waste management bye-laws adopted by the Kerala government. On the other hand, the BSMOSS identified households unwilling to be a part of the initiative and through regular follow-ups by the SHG members to such households a good amount of public participation was achieved.

4: Acknowledging and Empowering Informal Waste Workers and Addressing Gender-sensitive Issues

- **Validate the efforts of informal waste workers.**

In India, the high recycling efficiency of ~ 60%⁴⁷ has been achieved because of the valuable contribution of the informal sector which consists of self-employed individuals who are not recognized and protected under any laws.

The informal sector plays a pivotal role in sound waste management of our country. Producers and brand owners must consider contributing towards consolidating or aggregating the services of the informal sector. The formalization of the informal sector should be covered under EPR frameworks since its better implementation requires shared responsibility as it cannot just be accomplished by ULBs. This will help the informal sector by providing them a respectable livelihood. Similarly stakeholders such as cement plants that co-process RDF need to contribute part of the savings accrued from fuel cost or CSR investments which in turn will consolidate the informal sector. This way the existing available instruments would be environmentally-sustainable and used optimally.

There are cases where municipal corporations integrated the informal sector to the formal sector. However, because of the low pay in the formal sector, the formalized workers continued to work in the informal sector. For instance, the Raebareli Municipal Council included 25 informal waste workers who are residents of Raebareli employed in the waste management industry. The ULBs trained them on segregation of recyclables, and created awareness regarding the associated hazards, and health risks of working in this sector. The ULBs also provided them with personal protective equipment and ID Cards. Nevertheless, despite numerous ULB attempts, it has been noted that these now-formal waste workers also work informally in the district because the pay for doing so is higher. As a result, in order to integrate the informal sector, a sustainable funding mechanism must be developed to fund their activities.

⁴⁷Pandey, S. (n.d.). Waste recycling issues and opportunities. [online] Available at: <https://www.teriin.org/sites/default/files/files/waste-recycling-issues-and-opportunities.pdf>

Informal sector integration is not just necessary to recover maximum resources during collection but also to help the municipalities in cost reduction of waste management services. For example, in Pune, informal waste collection saves the Pune municipality an approximate of INR 16M (approx. USD 220,000) annually in transportation costs alone.⁴⁸ The activities for informal sector integration may include positive communication and media strategies, identifying potential informal networks in the city, providing ID cards, protective gear, health check-ups, social security schemes, and payment schedules.^{49,50} Communicating such issues to the informal workers in their own language is a critical step in empowering workers, standardising their livelihoods, and ensuring respectful conditions for workers. The cities, in collaboration with NGOs, must also seek to increase the employees' capability by giving them equipment and workspace, technical training, permission to perform door-to-door garbage collection, and the ability to collect user fee charges for collection.

- **Understand women's essential role in development of sustainable resource management and give women an equal position in public position, political leadership, and decision making.**

Women, in general, are more inclined to recycle; they have a better understanding of local ecosystems, and they make more sustainable decisions for their families and others.⁵¹ Yet, men still hold the majority of green employment and have greater access to green technologies.⁵² Further, the vast majority of industrial equipment and technology has been produced by and for males, and it is not necessarily suitable or accessible to women. Women's education and training possibilities are restricted, and resources and support for women's initiatives and entrepreneurship in the green economy are scarce. Child care, safe and dependable transportation and flexible working hours that allow women to combine household care and income-generation are all not considered. To enhance women's engagement in the green, clean and sustainable sectors, more effort must be put into mainstreaming gender into environmental policies and programmes, as well as a targeted approach to draw women into the field.⁵³

In India, there is a lack of essential baseline data, such as information on the number of women-led recycling cooperatives and informal waste collection/recycling networks. Such

⁴⁸Centre for Public Impact (CPI). (2021). Waste Management Cooperative: Pune, India. [online] Available at: <https://www.centreforpublicimpact.org/case-study/waste-management-cooperative-pune-india>

⁴⁹United Nations Environment Programme (UNEP), Coordinating Body on the Seas of East Asia (COBSEA) (2019). Marine plastic litter in East Asian Seas: Gender, human rights and economic dimensions [online] Available at: <https://www.unep.org/cobsea/resources/report/marine-plastic-litter-east-asian-seas-gender-human-rights-and-economic-dimensions#:~:text=This%20report%20provides%20insights%20on>

⁵⁰Ministry of Housing & Urban Affairs (2019). The Critical Role of Community Based Organizations in Urban Sanitation and Waste Management. [online] DeendayalAntyodayaYojanaNational Urban Livelihoods Mission. Available at: <https://nulm.gov.in/PDF/ResourceMaterial/COMPENDIUMONBESTPRACTICE.pdf>

⁵¹ OECD-ilibrary.org.Home. [online] Available at: <https://www.oecd-ilibrary.org/sites/7ff96708-en/index.html?itemId=/content/component/7ff96708-en>.

⁵²Stevens, C. (2009). GREEN JOBS AND WOMEN WORKERS Employment, Equity, Equality. [online] Green Growth Knowledge Platform. Available at: https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Green_jobs_and_women_workers_employment_equity_equality_Sustainlabour.pdf.

⁵³GUIDE ON GENDER MAINSTREAMING ENVIRONMENTAL MANAGEMENT PROJECTS. (2015). UNIDO. [online] Available at: https://www.unido.org/sites/default/files/2015-02/Gender_Environmental_Management_Projects_0.pdf

data might be used to develop policies that meet employees' needs and provide social benefits.

More studies are needed to understand the contributions of informal waste management operations to formal waste management systems, as well as the social and economic implications of these systems. Such studies, when paired with gender-specific statistics on the number of people employed in the formal and informal waste management industries, can help policymakers develop gender-responsive policies.

In India, there are cities in Maharashtra (Beed), Kerala (Calicut, Kochi), and Goa (Panaji) that are torch-bearers in the field of involving women in the sector and giving equal opportunities as men. The following points highlights some of the initiatives that the cities have implemented to empower women waste pickers:

- Integrating them into the city's solid waste management system and providing them income-generating opportunities;
- Increasing their access to social welfare benefits, programs, and services;
- Improving public and occupational safety for waste pickers;
- Transitioning from informal to formal economy by giving access to decent incomes, financial services, social protection, education, skill development, provision of crèches and anganwadis (rural child care centre in India where children are cared for during the working day), partnership with NGOs and worker unions;
- Building women's leadership and making their voices reflect in policy making'
- Implementing policy changes that prioritize outreach to women in government relief schemes, including extending cash grants, food-relief, and social protection measures targeting women workers;
- Providing access to health insurance, pensions, and old age homes; and
- Empowerment through recognition by giving an identity card.

SafaiSena – an army of cleaners

In collaboration with the Delhi government, Chintan Environmental Research and Action Group, a NGO, established the SafaiSena – meaning an army of cleaners – of registered waste pickers, doorstep waste collectors, itinerant purchasers, small junk dealers, and other forms of waste recyclers. Its goal is to ensure that waste recyclers' work is recognised and that they have safe and secure working conditions. Every month, employees are paid a minimum of INR 8,400 and are covered by health insurance and also given protective gear such as shoes, gloves, and masks, with only a small portion of their earnings used to run the initiative. For the children of SafaiSena members', Chintan's "No Child in Trash" initiative operates 15 centres that provide classes to prepare them for municipal schools. Chintan also trains the teachers for the same.⁵⁴

⁵⁴SAFAI SENA -CHINTAN. (n.d.). [online] Available at: <https://www.indiasanitationcoalition.org/resources/Case-Study-Chintan.pdf>

- **The role of community-based organizations of women-led self-help groups in waste management must be acknowledged. Successful models could be replicated in other locations to uplift the lives of underprivileged communities in society.**

Community-based waste management initiatives may require initial cooperation, guidance, and funding from local authorities and/or non-governmental organisations (NGOs) in order to establish an effective waste management programme and run it independently.⁵⁵ Most of the community groups formed are women's Self-Help Groups such as the Harithakarma sena in Kerala, and BSMOSS in Maharashtra. In these groups, with the help of ULBs and/or NGOs, the underprivileged and unemployed women from the community found a stable source of income generation and strengthened their livelihood. Involving people from the community itself was the key success factor of these initiatives as they took it upon themselves to ensure that the initiative was successful. Not just that, access to households is much higher for local SHGs as residents trust them.⁵⁶

Though there are successful case studies of women-led SHGs in rural and semi-urban areas, their replicability to urban localities of the country has been limited as jobs in the waste sector are, more often than not, deemed as unfavourable, due to low-wages and unsteady income generation. Community mindsets could be changed if the perception of "waste as a resource" is actively promoted, waste workers are acknowledged for their efforts, and sustainable income is provided; with this, the waste sector could be projected as a gainful and sustainable employment-offering sector.

The socio-political-economic system is different across the cities in India. For instance, in Kerala, the community network system called Kudumbasree, and government organizations, and other institutions are very strong and supportive. Community-based participatory models must be used to implement such women-led SHG models in other cities. The successful implementation of such models requires a strong participatory mechanism and capacity development initiative, which should go hand-in-hand. The following are the key steps to be taken to bring about a change:

- **Formation of SHG:** IEC activities by the ULBs and/or NGOs could be conducted for the gathering of women for the formation of self-help groups. The SHG can be made responsible for IEC activities in households and commercial establishments, door-to-door waste collection, waste segregation, user-fee collection from households and commercial establishments, dry waste selling, making compost of wet waste and further selling the manure, creating value-added products, and so on.
- **Opening of bank accounts:** Bank accounts could be opened for the members of the SHGs. The payment shall be scheduled on certain dates of every month and in accordance with the attendance, the payment should directly deposit in the bank accounts. For those who do not have bank accounts, the ULB and/or NGOs could facilitate opening their accounts under the Jan DhanYojana scheme.⁵⁷ Each woman of the SHGs should be considered as a shareholder. Whatever they earn from the sale of dry waste, compost, value-added

⁵⁵COMMUNITY-BASED WASTE MANAGEMENT.(n.d.).*Urban Agenda Platform*. [online] Available at: <https://www.urbanagendaplatform.org/best-practice/community-based-waste-management>

⁵⁶WASTE-WISE CITIES Best practices in municipal solid waste management NITI Aayog. (2021) [online] Available at: <https://www.niti.gov.in/sites/default/files/2021-12/Waste-Wise-Cities.pdf>

⁵⁷COMMUNITY-BASED WASTE MANAGEMENT.(n.d.).*Urban Agenda Platform*. [online] Available at: <https://www.urbanagendaplatform.org/best-practice/community-based-waste-management>

products made out of waste, and user fee collection should be divided among them and the gap funding could be provided by the ULBs.

- **Training & Capacity building:** Hand-holding capacity building programs shall be conducted for the SHGs, with practical operating tips on waste management, office management, accounting and bookkeeping.
- **Social Security:** As part of their social security, health cards should be issued to the workers and quarterly health check-ups by a qualified doctor should be organized. They could also be provided with access to health insurance, pensions, and old age homes. A rotating weekly holiday should be accommodated, in accordance with labour laws.
- **Acceptance among the society:** Sensitization training such as distribution of IEC materials, pamphlets, and awareness campaigns about the role and the importance of the SHGs among the community should be conducted for the social acceptance of the SHGs.
- **Support from all the stakeholders:** With the support and encouragement from the relevant administrative bodies such as Gram Panchayat, Nagar Palika, Nagar Panchayat, and Municipal Corporation, women-led SHG models could be replicated to other parts of the country as well. The workers should be well treated and respected by the society and be appreciated for their hard work by all the concerned stakeholders. The local bodies shall further support by ensuring that user fees are being collected properly and support them wherever they face the problems of social acceptance. The local bodies should also have provision of viability gap funds to ensure sustainability of the self-help groups.

5: Setting Up Viable Business Models

- **To explore the viability of expanding the utilisation of MSW-based RDF in cement plants, in compliance with environmental and social standards.**

Co-processing of RDF can provide ULBs with an option for managing non-recyclable waste as well as the opportunity to conserve natural resources, as co-processing involves waste combustion with no residual leftover. The government has also realized the potential of this technology and introduced the "Guidelines on Usage of Refuse Derived Fuel in Various Industries". However, at present, there is a lack of a feasible business model to derive the environmental and economic benefits of RDF co-processing. To address this gap, the vested interests of all relevant stakeholders needs to be identified and taken into account in order to explore potential synergies. For instance, PIBOs wish to reduce their EPR liabilities; cement plants wish to reduce CO₂ footprint and fuel; the ULBs are trying to create a clean environment and a zero landfill city; the waste management agency (WMA) are looking for better economics of waste management; and plastic recyclers want cost effective production of recycled post-consumer content. These expectations and "wish lists" of key stakeholders such as PIBOs, ULBs, WMAs, and cement plants can be leveraged to establish opportunities for the development of viable business models.

Cement plants in India have been designated as 'Designated Energy Consumers' (DC) and given specific energy consumption targets (SEC). Cement plants could improve their SEC figures by using RDF instead of coal. RDF co-processing in cement kilns is a safe and

sustainable method of achieving a "zero waste" solution.⁵⁸ The barriers which prevent ULBs, cement plants, and other stakeholders from supporting RDF production and co-processing of RDF in cement and waste-to energy-plants are:

- Lack of awareness regarding the aspects such as offset of EPR liabilities by PIBOs;
- Lack of standard data regarding the biomass content of the different types of the RDF,
- Need for ULBs to match the required quality parameters (such as moisture content, calorific value, chlorine, etc) for sending RDF to cement factories;
- Return on investment of technologies introduced;
- The capital cost of the MSW being sent for co-processing;
- Increase in transportation costs when RDF has to be transported over long distances to reach the cement plant. This can result in higher fuel costs and carbon emissions;
- Lack of guaranteed supply of MSW;
- Inadequate financial support for encouraging RDF co-processing in cement kilns; and
- Lack of long-term agreements in place between urban municipalities, waste processing corporations, and cement manufacturers.

To realize the environmental and economic benefit of RDF co-processing for all stakeholders, a business model with a win-win approach must be institutionalized. A successful business model would be where, for instance, the WMA/ULB does the pre-processing from SCF to RDF, and the financial implications required for the preparation of RDF and associated transportation cost comes from the PIBO and ULBs. This way the PIBO and ULB are able to meet their obligations and the cement plant will receive the RDF at no cost.

- **Establish sustainable financing mechanisms for waste management in the city.**

A lack of sustainable financing mechanisms for waste management is one of the key obstacles for expanding existing waste management services in many cities of India. The majority of the ULBs already have the information on how many staff and vehicles are present and needed for waste collection and transportation, and the type and capacity of technologies that they would like to get installed, but this information is not readily available from other stakeholders involved in waste management, which is a challenge. Waste management plans would provide an adequate measure to realize the required revenues or subsidies in order to achieve financial sustainability as it presents various scenarios for financial requirements based on the desired service levels.⁵⁹

Decentralised techniques such as pit composting, vermi-composting, MRFs and small scale anaerobic digestion have the potential to minimize transportation costs, ground water contamination due to leachate seepage, and waste in disposal sites.

Promoting decentralised waste management systems with a community-based model is not only sustainable and financially feasible, but it also helps to enhance waste employees' quality of life and working conditions. The operations of informal waste workers, such as the rigorous collection of user fees and income from the sale of compost and dry garbage,

⁵⁸Editor, C.I.J. - (2018). Cement kiln Co-processing to achieve India's 'Mission Zero Waste'. [online] Clean India Journal. Available at: <https://www.cleanindiajournal.com/cement-kiln-co-processing-to-achieve-indias-mission-zero-waste/>

⁵⁹Renaud, P., Lateheru, J. and Kerbach, R. (2018). Marine Litter Prevention. [online] GIZ.de. Available at: https://www.giz.de/de/downloads/giz2018_marine-litter-prevention_web.pdf

create a sustainable financial model for waste management programmes. Additional revenue for operating expenditures may be obtained through the adoption of private partners and EPR mechanisms, which would need action at national level. Outsourcing waste collection and transportation, integrating the informal sector, and managing treatment facilities allow local governments to save time and money by not having to deal with the aforementioned issues.⁶⁰

- **Increase allocation of CSR funds from industries and other organisations towards technology upgrades, deployment of waste-to-energy technologies, and for overall sustainable money flow in the MSW management.**

CSR funds from corporates can be an effective resource to continue spurring the growth of waste recycling, processing and disposal systems and infrastructure and land restoration, in addition to increasing awareness and sensitivity to environmental concerns among the general public. For instance, in India, Coca-Cola, Indian Tobacco Corporation (ITC), and IOCL have been implementing CSR-funded initiatives such as setting up new MRFs; spreading awareness among waste workers, scrap dealers, and local administration through the engagement of local NGOs/community organisations for capacity building; promoting home composting through capacity building and awareness programmes for village panchayats, SHGs, etc.; involving women's self-help groups in waste management projects; and setting up decentralized bio-methanation plants. However, there are ULBs that still face challenges in attracting businesses to take up waste management projects as it usually involves a longer term commitment as opposed to a one-time investment like building toilets.⁶¹ Companies require guaranteed support from the municipalities in the form of incentives, guaranteed supply of MSW, expertise, and technology set-up.

That being said, there are companies ready to invest in waste management infrastructure, and it is the ULBs prerogative to take the initiative to reach out and engage these companies within their respective jurisdictions. But a structured financing mechanism needs to be developed first, since relying 100% on private sector funds for a project may not be feasible in the long term. There are past examples of waste management projects where the private sector funds ~50%, municipalities fund 30-40%, and the rest (15%- 20%) is funded by the waste generators, which has proven to be a more viable funding structure to meet the running costs of waste management projects.

Some municipalities have managed to explore the expansion of waste-to-energy facilities as part of CSR-funded initiatives; for instance, Indian Oil initiated a municipal solid waste-to-fuel project in Varanasi, where a total of 10 decentralised units with a capacity of 5 TPD are in the process of being installed. The first plant was commissioned in December 2016, and the energy generated is utilised to power the street lights in nearby neighbourhoods.

⁶⁰WASTE-WISE CITIES Best practices in municipal solid waste management NITI Aayog. (2021). [online] Available at: <https://www.niti.gov.in/sites/default/files/2021-12/Waste-Wise-Cities.pdf>

⁶¹Manku, M. (2015). Garbage disposal finds no takers for CSR. [online]. Available at: <https://www.livemint.com/Companies/tNGdIGQ8rcGwYN3Ewn1czK/Garbage-disposal-finds-no-takers-for-CSR.html>

8 Appendices

Appendix 1: List of Topics Covered & Experts and Entrepreneurs Invited for the Workshops

S. No.	Workshop Number	Workshop Topic	Session Experts	Designation
1	Workshop 1	Public Consultation Workshop	Expert 1: Dr. Suneel Pandey	Director, Environment & Waste Management Division, The Energy and Resources Institute (TERI)
			Expert 2: Ms Laura Bennis	Director, Programme at SecondMuse, The Incubation Network
2	Workshop 2	Translating National Rules to Local Bye-laws (Solid and Plastic Waste Management 2016)	Expert 1: Dr. Suneel Pandey	Director, Environment & Waste Management Division, The Energy and Resources Institute (TERI)
			Expert 2/ Entrepreneur/ NGO: Dr. Smita Mohanty	Director & Head (Principal Scientist), LARPM, CIPET
3	Workshop 3	City Action Plan for Phase-out of Single-Use- Plastics	Expert 1: Ms Swati Sambyal	Waste Management Specialist, UN- Habitat
			Expert 2/ Entrepreneur/ NGO: Ms Nivedha R M	CEO & Founder, Trashcon Private Limited
4	Workshop 3	Centralized & Decentralized Wet Waste Processing Technologies	Expert 1: Dr Dinesh Chander Pant	Senior Fellow, Centre for Waste Management, The Energy and Resources Institute (TERI)
			Expert 2/ Entrepreneur/ NGO: Mr Ankit Bhandari	Country Manager, Alfa Therm Limited
5	Workshop 5	Integration of Informal Sector into the Formal Waste Management System	Expert 1: Mr. Praveen Nayak	Founder, Garbage Clinic
			Expert 2/ Entrepreneur/ NGO: Mrs.KesarKshirasagar	President –BSMOSS BeedSwachhata Mission Organic SakhariSamiti- Maharashtra

6	Workshop 6	Empowering Women Waste Pickers in Waste Collection and Recycling	Expert 1: Ms. Chitra Mukherjee Expert 2/ Entrepreneur/ NGO: Ms. Carolina C. Neriamparampil	Consultant, Waste and Sustainable Livelihood Ph.D. Research Scholar, Royal Holloway, University of London, United Kingdom
7	Workshop 7	Bio-remediation/ Scientific Landfill Closure	Expert 1: Mr. Masood Mallick	Chief Executive Officer (CEO), Re Sustainability limited (formerly RamkyEnviro)
8	Workshop 8	EPR Policy & Implementation	Expert 1: Mr. Ashish Jain	Founder Director, Indian Pollution Control Association (IPCA)
9	Workshop 9	Corporate Social Responsibility	Expert 1: Mr. Amit Kumar Thakur	Head, CSR initiatives, The Energy and Resources Institute (TERI)
10	Workshop 10	RDF Co- processing	Expert 1: Mr. Ullas Parlikar Expert 2/ Entrepreneur/ NGO: Mr. Abhishek Tawre	Global Consultant Growth Unit Head – WTE, Thermax Babcock & Wilcox Energy Solutions Private Limited
11	Workshop 11	Essential Role of Women in the Development of Sustainable Resource Management from Waste Management Perspective	Expert 1: Dr. Radha Goyal Expert 2: Ms. Tripti Shinghal Somania	Deputy Director, Indian Pollution Control Association (IPCA); National Secretary, Society for Indoor Environment (SIE) Founder, Womannovator; CEO, KGS Advisors; TEDx Speaker
12	Workshop 12	Final Dissemination Workshop	Expert 1: Dr. Suneel Pandey Mr. Leejan D'souza Ms. Nalini Shekar Dr. N B Mazumdar,	Director, Environment & Waste Management Division, The Energy and Resources Institute (TERI) Corporation of City of Panaji. Co-founder & Executive Director, Hasiru Dala Hon. Chairman, International Academy of Environmental Sanitation and Public Health New Delhi.

Appendix 2: Summary of the Workshops Conducted

Workshop 1: Translating National Rules to Local Bye-laws (Solid and Plastic Waste Management 2016)

The experts in this workshop discussed solid waste management-related laws and how to translate national rules to local bye-laws. From the workshop it was understood that ULBs are finding it difficult to interpret the amendments, and by the time they incorporate the amendments into their bye-laws the new amendments are notified. They are also finding it difficult to manage low-value plastics as it doesn't have any resale value. Urban local bodies are finding it difficult to manage the packaging waste, as the majority of plastic waste generated is from packaging.

Key takeaways:

- Municipal corporations can design their bye-laws by interpreting the national rules. Bye-laws can differ from one city to another. For instance, there are certain provisions that cannot be standardized in terms of user charges and fines. In this regard, the city government can take the decision in setting up the user charges and fines.
- Since plastic waste management provides a unique cross-cutting opportunity to contribute to 14 of the 17 Sustainable Development Goals (SDGs), it is critical for a city to develop an action plan for the phase-out of single-use plastic.

Workshop 2: City Action Plan for Phase-out of Single-Use- Plastics

The experts in this workshop discussed various cities' action plans to phase out single-use plastic and how to handle low-value plastics with innovative technologies. From the workshop it was understood that urban local bodies were interested in the various technologies and alternatives that are gradually being introduced in the market. Authorities were concerned about the biodegradable plastic that are being introduced in the market as they are concerned about creating a parallel stream of waste as these decompose under certain conditions.

Key takeaways:

- Along with finding alternatives to plastic, we should also have to look at local resources and identify what is available at city level and something which does not have to be procured from any other state.

Workshop 4: Centralized & Decentralized Wet Waste Processing Technologies

The experts in this workshop discussed various centralized & decentralized wet waste processing technologies and effective ways of managing wet waste.

Key takeaways:

- Urban local bodies were interested in the various technologies and keen to adopt the presented technologies to manage their wet waste.
- Participants were interested in the technologies for compostable plastics which are creating a parallel stream of waste.
- City officials were interested in the technology which can exclusively manage their leaf waste as it is generated in a significant amount.

Workshop 5: Integration of Informal Sector into the Formal Waste Management System

The experts in this workshop discussed the integration of the informal sector into the formal waste management system along with explaining the case study of BeedSwachhata Mission Organic SahkariSamiti-Maharashtra (BSMOSS). It was understood that Urban Local Bodies find it difficult to integrate informal workers into waste management models.

Key takeaways:

- Self-sustaining waste management models are a win-win situation to all the stakeholders involved in the waste sector. Such models will provide rag-pickers, underprivileged women and other unemployed people a better work environment and income. Expenses for municipal corporation will also decrease.

Workshop 6: Empowering Women Waste Pickers in Waste Collection and Recycling

The experts in this workshop discussed empowering women waste pickers in waste collection and recycling and discussed women in the waste management industry & the example of Haritha Karma Sena. Urban local bodies are finding it difficult to formalize informal waste pickers. Budgetary constraints and workers being migrants are a few major issues highlighted by the ULBs as reasons for not being able to institutionalize the informal waste pickers.

Key takeaways:

- Gender equality and human rights principles should be integrated in policies and decision making processes in the waste sector. For this, data should be generated on the existing number of men and women waste pickers which could be used to formulate policies which would respond to the workers needs and social protection.
- In order to validate the informal sector's contribution, give them a collective voice through the creation of unions or cooperatives, so that they are able to negotiate sufficient earnings and health and safety equipment.
- Community sensitization programmes with proper support from local bodies are an integral component of waste management programmes.

Workshop 7: Bioremediation/Scientific Landfill Closure

The expert in this workshop explained what bio-mining constitutes and discussed the important considerations and design principles to keep in mind while approaching any scientific landfill closure or rehabilitation. The expert also discussed the products and their uses that could be created from the waste present in the dumpsite.

Key takeaways:

- The composition of the waste is largely determined by the age of the landfill. Most of the landfills in India are very old and hence, barely comprise any biologically active waste. Therefore, more inert waste management projects to convert inert material into usable products must be initiated.
- It is significant to emphasize that there won't be sufficient confidence in the viability of legacy waste management businesses and the products produced from such waste until any legal framework supports and encourages them. Hence, policies must be proposed addressing recycled items and materials' demand, sale and purchase in markets. Policies must strengthen markets for such recyclables.
- Landfill Gas-to-Energy (LFGE) initiatives offer both a viable environmental service and a

profitable financial opportunity. Hence more such projects need to be introduced in our country.

- If the waste characteristics are well understood, developing the appropriate technology becomes easier. As the quality of products such as RDF coming from legacy waste is not as good as the products coming from a fresh waste, characteristics of waste must be carefully considered when planning waste-to-energy (WtE) solutions.
- More research is needed on the long-term impact of legacy waste on its future uses.

Workshop 8: EPR Policy & Implementation

The expert in this workshop discussed EPR policy & implementation, the Plastic Waste Management (PWM) Rules in India, policies of EPR and how they could be implemented.

Key takeaways:

- EPR implementation will commence when PIBOs accept the policy tool throughout their value chain. And in doing so, PIBOs could assist ULBs in reducing the amount of plastic waste being dumped in landfills. Over time, ULBs will be able to improve the efficiency of source segregation, build more MRFs and collection points for waste management, and train waste collectors to make waste management more effective and skill-driven.
- In the recent few amendments of PWM rules, 2016 in India, definitions for biodegradable and compostable plastics have been added. However, there has been a noticeable lack of clarification regarding the terminology of biodegradable and compostable plastics at the city and consumer level. The on-going SUP phase-out has greatly boosted the demand for these products in the market. As a number of companies are attempting to enter the market with products claiming to be biodegradable, standards for biodegradable plastic, similar to the compostable plastic standard (IS 17088:2008), should be established sooner.
- Multi-layered plastics, which are made up of multiple layers of plastic and are extremely light, are often ignored by the waste collector and recycling sector. Few buyers exist for MLPs, and those that do are frequently unable to provide a competitive price. As most of the MLPs are recyclable, the establishment of more recycling units/facilities in India is one of the interventions that might be used to change this scenario. In this manner, recyclers could direct the demand for MLPs and encourage waste collectors to collect them. Through EPR, PIBOs can also encourage waste collectors to collect MLPs and then direct the materials to waste-to-energy and cement plants for co-processing.
- The informal sector that is an integral part of waste management turns waste into useful and marketable commodities. As most of the plastic is channelized through the informal sector, it should be formalised and included in the EPR. This might be accomplished by including them in ULB's daily activities carried out as part of the waste management process. With the help of ULBs and other organisations, waste collectors may be given storage space to segregate the waste they collect. Capacity building and training should be provided to the informal sector in order to improve their skills and knowledge for segregating different types of plastic and other streams of waste.
- Collection of cigarette butts may be the most challenging part of managing this stream of waste. The inclusion of cigarette butt litter under Plastic EPR will have a profound impact on the product's environmental impact. With this, behavioural change is also an important step that needs to be done. If appropriate behavioural change is brought and people start to dispose of them in dustbins, collection of cigarette butts could be made easier.

Workshop 9: Corporate Social Responsibility

The expert in this workshop discussed how to attract CSR-funded initiatives in the waste sector. The expert explained the benefits of CSR funds in building waste-to-energy plants. He further explained how waste-to-energy is a solution to both circular economy and energy and climate change.

Key takeaways:

- Waste-to-energy (WtE) technologies offer an easy solution for both energy production and environmental concerns. WtE, can benefit the economy, society, and environment by using resources more effectively and emitting less pollutants. When compared to other fossil fuel-powered generation options, WtE is frequently seen as a pricey option for waste disposal and energy generation. Therefore, WtE projects must be launched as a part of the CSR drive.
 - The majority of biodegradable waste is dumped in landfills. Such materials in landfills cause methane emissions from landfills. Large technologies used in waste management take a long time, a lot of money, and a lot of space to create. Composting biodegradable waste is a cost-effective way of waste disposal. Composting at the household level, such as vermicomposting, is less expensive and takes up less area, which will eventually reduce the quantity of waste going to landfill. This compost could be further used by farmers and gardeners who would then spend less money on expensive fertilisers and pesticides.
 - Corporate partnerships with informal workers can be helpful in the skill development and integration of informal sector workers. Through these partnerships, the sector will be able to access better technologies where they work and develop their skills and increase earnings. Such collaborations with informal workers can also assist the core business of a company because the abilities of informal workers can be useful and have various advantages.
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Workshop 10: RDF Co-processing

The experts in this workshop talked about the environmental and economic advantages of RDF co-processing. The experts also discussed ways to develop a feasible business model to derive the environmental and economic benefit of RDF co-processing. New technologies for RDF co-processing in cement plants introduced by the Thermax Babcock & Wilcox Energy Solutions Private Limited such as the FlexiSource and multipass boiler were also discussed.

Key takeaways:

- RDF is regarded as a green fuel that leads to a green environment. It addresses both the municipal waste problem and the energy demand.
 - Co-processing of RDF at cement kilns is a safe and sustainable way to achieve a “zero waste” solution as with the utilization of RDF there are no emissions produced that are a cause of concern because of the high temperature of the cement kilns. Guidelines by CPCB and MoHUA are present for the effective utilization of waste from dumpsites and on the specification of RDF for use in the cement kilns, respectively.
 - To derive the environmental and economic benefit of RDF co-processing by the stakeholders, a business model with win-win approach is essential. To develop a feasible business model to derive the environmental and economic benefit of RDF co-processing the wish list of all the major stakeholders must be taken into account.
 - There are several aspects that make RDF better than coal, including its cost-effectiveness: the cost of one ton of RDF is only about Rs.2000 but coal is about Rs 6000. Another parameter is the moisture content. The moisture content in RDF is much less than that of coal, hence the calorific value of RDF is better.
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- Provisions to offset EPR obligations by the cement plants must be introduced.
 - The potential market for RDF with the support of private sector engagement and better technologies is needed. Industries are looking for solutions to migrate to new fuels based on fuel sourcing and equipment design. Private companies such as Thermax Babcock & Wilcox Energy Solutions Private Limited are considering fuel sourcing, keeping in mind the cost, availability, the environmental impact and the waste disposal. They are also designing equipment that is reliable, available, efficient, and flexible.
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Workshop 11: Essential Role of Women in the Development of Sustainable Resource Management from Waste Management Perspective

The session discussed how women play a key role in the management, conservation, and utilization of resources and yet, their access to public position, political leadership, and decision making is limited in general as well as in the waste management system.

Key takeaways:

- Change attitudes about gender norms through proper awareness generation.
 - Conduct more research and collect gender-disaggregated data to address gender inequality in the waste sector.
 - While introducing technologies, make sure women are also part of the training for the technology usage.
 - There is a need to increase women's participation in public positions, political leadership, and decision making.
 - Policies and practices in the waste sector need to be gender-sensitive.
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The Centre for Waste Management (CWM) at TERI has been striving towards the development of solutions for providing sustainable and economical waste management in the country. Various projects in the field of sanitation, solid waste management have been undertaken at the CWM of TERI. TERI has also supported programmes for facilitation of good governance and ensuring universal access to improved environmental services namely solid waste, waste water management, improved sanitation. TERI has undertaken Capacity building in urban and rural areas, public awareness, environmental education and community development.



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