

Municipal Solid Waste Management in India: Challenges, Technologies and Linkages with Sustainable Development Goals

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Abstract—Solid Waste Management (SWM) is one of the prominent fields of study in India. In the past few decades, the country has witnessed a significant population shift into urban areas. As a result, new social structures and patterns of consumption have emerged. The issue of trash, which is increasing in amount and changing in composition, is brought on by the fast change in lifestyle brought about by urbanization and modern urban living. Because publically available municipal solid waste (MSW) information is generally few or dispersed, the situation is frequently unclear and the answers are imprecise. To examine the macro-issues that Indian techno-financial managers face, this research tries to compile accessible data. Urban solid wastes form the central theme of the study.

Index Terms—municipal solid waste (MSW), Landfills, Composting, Sustainable Development Goals (SDGs)

I. INTRODUCTION

Rapid economic development, urbanization, and improvement in living standards in Indian cities have led to a significant rise in both the volume and complexity of waste generation. Managing municipal solid waste (MSW) has thus become an increasingly complex challenge for government agencies, pollution control authorities, and regulatory bodies. Improper disposal and inadequate management of MSW contribute to widespread environmental degradation, including groundwater contamination, air pollution and the spread of infectious diseases. These problems not only compromise public health but also adversely affect ecosystems and the overall biosphere (Annepu, 2012; Earth Engineering Centre, 2012).

With increasing migration to urban areas, changing lifestyles, and high population density, a paradigm

shift is required in India's approach to waste management. There is an urgent need for sustainable, inclusive and technologically advanced solutions to ensure public health, environmental protection and resource optimization (Planning Commission, 2014).

II. BASELINE SCENARIO

A. Trends in MSW Generation

A study by Annepu (2012) analysed data from 366 Indian cities between 2001 and 2011 and found a 50% increase in MSW generation within one decade. The study further predicted that urban India would generate 107.01 million tons per year (TPY) by 2031 and 160.96 million TPY by 2041- a five-fold increase over four decades (Annepu, 2012).

B. Waste Collection, Composition and Per Capita Generation

The government estimates that only 75-80% of MSW is collected and of this, merely 22-28% is treated or processed. The remaining waste is dumped at landfill sites. The composition of waste includes over 50% organic matter, 31% inert waste, and 18% recyclable material (Earth Engineering Centre, 2012). Organic waste, which is compostable, constitutes a large proportion of the total waste stream.

The per capita waste generation rates are:

- Small towns: 200-300 grams per capita per day
- Medium cities: 300-400 grams per capita per day
- Large cities: 400-600 grams per capita per day (Planning Commission, 2014; CPCB, 2018).

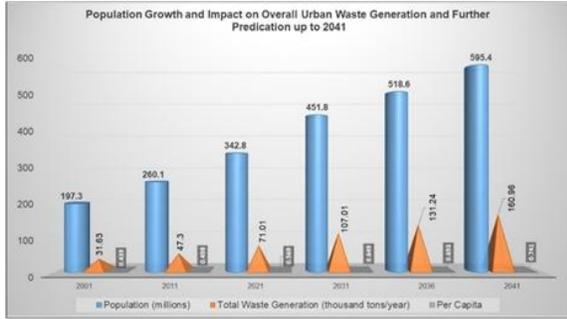


Fig. 1. Projected MSW Generation in India (Annepu, 2012)

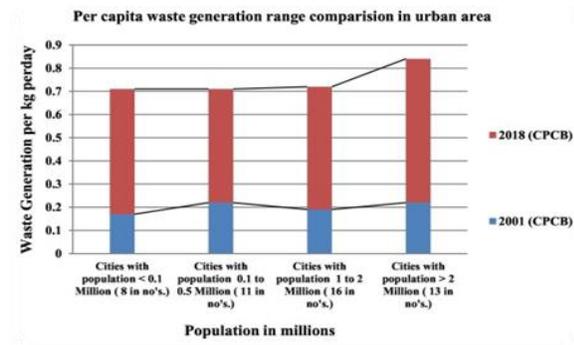


Fig. 2. Per capita waste generation comparison in Indian cities (S. Kumar et al., 2017) (CPCB India, 2018a)

C. Characteristics of Waste

The majority of MSW in Indian cities is biodegradable due to high moisture content and elevated temperatures. This necessitates frequent collection and disposal, placing additional stress on already strained waste management systems.

D. Governance and Institutional Framework

Waste management in India is governed by local civic bodies under the respective Municipal, Corporation, or Panchayat Acts. These legislations require updates to reflect current challenges. In most cities, waste management is the responsibility of health officers, supported by engineering departments for transport and logistics. Poor coordination between departments often leads to ineffective service delivery (CPCB, 2018).

The Municipal Solid Waste (Management and Handling) Rules, notified in 2000 and operational from 2004, mandate that urban local authorities handle waste collection, transportation, treatment and disposal. However, due to lack of funding, inadequate technology adoption and institutional inefficiencies,

compliance remains low. Open dumping continues to pose serious environmental and public health risks (MoEFCC, 2016).

III. WASTE DISPOSAL PRACTICES IN INDIA

A. Open Dumping and Its Impact

Open dumping is the predominant method of waste disposal in India. Inadequate barriers allow leachate to seep into the soil, contaminating groundwater and adversely affecting nearby communities. Decomposing waste emits foul odours and methane- a potent greenhouse gas- constituting 50-60% of landfill emissions and contributing to global warming (IPCC, 2014).

B. Engineered Landfills and Mitigation Efforts

To reduce the harmful effects of waste disposal, several urban bodies are adopting engineered landfills that include:

- Effective leachate collection and treatment systems.
- Methane capture and utilization infrastructure.
- Scientific sealing of waste to prevent environmental contamination.

Approximately 90% of non-recyclable waste requires around 1,200 hectares of land annually at an average depth of 3 meters (MoHUA, 2018). Planning for sufficient land use is essential in the current state of accelerating urbanization.

IV. WASTE PROCESSING TECHNOLOGIES

Recognizing waste as a resource rather than a liability is key to mitigating its negative impacts. Waste can support livelihoods, improve soil fertility, and reduce pollution when managed sustainably.

A. Classification of Waste Treatment Technologies

Technology Group	Technologies
Thermal Processing	Incineration (mass burn), Pyrolysis, Pyrolysis/Gasification, Plasma arc gasification
Biological Processing	Aerobic Digestion (Composting), Anaerobic Digestion, Bio-methanation, Landfills as Bioreactors
Mechanical Processing	Refuse Derived Fuel (RDF), Densification/Pelletisation, Mechanical Separation, Size Reduction

B. Composting as a Solution

Composting is considered the simplest and most feasible technology for managing India’s organic waste. It facilitates nutrient recycling but requires segregation of inert materials. Informal recyclers such as scavengers and Kabaris help in achieving this segregation in many urban centers (Earth Engineering Centre, 2012).

Marketing compost remains a significant challenge, and government support through subsidies and awareness campaigns is necessary. Composting benefits farmers by providing organic soil nutrients while simultaneously addressing waste disposal problems (Ministry of Agriculture, 2017).

V. FUNDING AND INSTITUTIONAL MODELS

A. Financial Challenges

Waste management is capital-intensive, with high sunk costs and economies of scale. Increasing demand due to population growth is straining municipal budgets, limiting compliance with regulatory frameworks.

B. Public-Private Partnerships (PPP)

PPP models are increasingly being explored as a solution. By combining public oversight and private expertise, PPPs offer cost-effective, efficient waste management services. Shared investment, risk, and responsibility between sectors can ensure better implementation and improved infrastructure (World Bank, 2018).

VI. WASTE MANAGEMENT AND SUSTAINABLE DEVELOPMENT GOALS (SDGS)

The United Nations’ Sustainable Development Goals (SDGs), adopted in 2015, aim to create a better world by 2030. Waste management plays a critical role in achieving these goals.

A. Direct Contributions to SDGs

SDG No.	Goal	Waste Management Contribution
SDG 3	Good Health and Well-being	Reduces disease and infection through proper waste disposal

SDG No.	Goal	Waste Management Contribution
SDG 6	Clean Water and Sanitation	Prevents contamination of water bodies
SDG 7	Affordable and Clean Energy	Enables waste-to-energy solutions like biogas
SDG 11	Sustainable Cities and Communities	Enhances urban hygiene and infrastructure
SDG 12	Responsible Consumption and Production	Encourages recycling and resource efficiency
SDG 13	Climate Action	Reduces emissions through proper waste handling
SDG 14	Life Below Water	Minimizes plastic pollution and protects marine biodiversity

B. Indirect Contributions to SDGs

SDG No.	Goal	Waste Management Contribution
SDG 1	No Poverty	Provides livelihoods to informal workers
SDG 4	Quality Education	Creates cleaner educational environments
SDG 5	Gender Equality	Empowers women in waste management roles
SDG 8	Decent Work and Economic Growth	Generates jobs and attracts green investments

VII. CONCLUSIONS

- a. **Priority to Waste Management:** Waste management must be treated as a critical public service to address the challenges of urbanization.
- b. **Current Challenges:** Inadequate funding, poor infrastructure, and weak governance hamper service delivery.
- c. **Environmental and Health Risks:** Without proper disposal methods, pollution and disease burdens increase.
- d. **Role of Clean Development Mechanism (CDM):** Carbon financing can overcome technological and financial barriers, making methane avoidance projects viable.

- e. Future Outlook: Policy reforms, investments, and international financing can accelerate large-scale implementation of sustainable waste management solutions, contributing to both environmental and human health improvements.

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