

ADDRESSING CHALLENGES IN MUNICIPAL SOLID WASTE MANAGEMENT: A STUDY OF PRACTICES AND TECHNOLOGIES IN INDIAN CITIES

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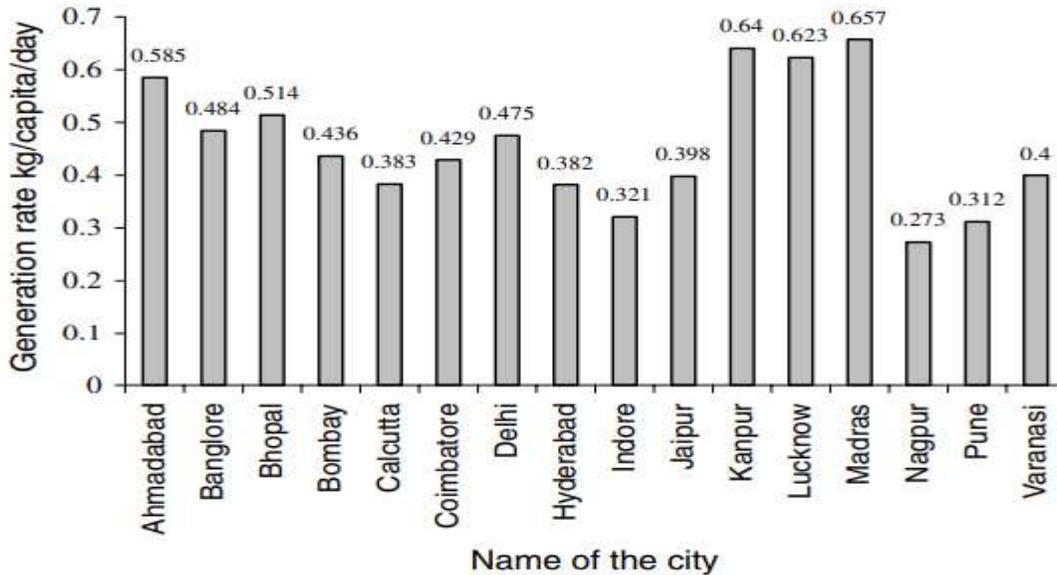
Abstract

Improper disposal techniques damage public health and the environment, making municipal solid waste management (MSWM) a critical environmental concern in Indian towns. The features, production, collection, transportation, disposal, and treatment technologies of municipal solid waste (MSW) in India are covered extensively in this paper. The report highlights the crucial need for effective MSWM tactics by evaluating the current status and identifying important challenges. We take a close look at different treatment technologies and point out what works and what doesn't. To encourage responsible authorities and academics to actively pursue sustainable waste management, the paper finishes with practical recommendations to enhance MSWM practices even further.

Keywords: MSWM, Storage, Collection, India

Introduction

Indian cities produce massive quantities of MSW every day because to the country's fast industrialization and population growth, which have driven many people from rural to urban areas. As India strives to become an industrialized nation by 2020, this trend is predicted to intensify. The problem is that municipal solid waste (MSW) accumulates in every part of cities due to insufficient collection and transportation facilities. There aren't enough facilities to handle the growing amount of garbage, especially in major cities, which is making this already difficult component of MSW management worse. One of the biggest environmental problems that Indian megacities are facing is MSWM, which is caused by unscientific disposal practices that hurt both people and the planet. Many cities do not have complete MSWM systems and only handle a portion of the tasks that should be included, which include “generation, storage, collection, transfer and transport, processing, and disposal (**Suthar, Royal, & Ahada, 2016**). Rapid and unplanned urbanization is making MSW management more difficult and expensive by necessitating sufficient infrastructure, maintenance, and upgrades across all these activities. The provision of sufficient public services is further hindered by the financial constraints that municipal corporations encounter. In order to evaluate the present state and identify obstacles, this study intends to give a thorough evaluation of MSWM in Indian cities. In addition, it suggests ways to improve the current system and aims to get scholars and relevant authorities to do something about it.



Per capita generation rate of MSW for Indian cities

Figure 1.1 shows that certain states (Gujrat, Delhi, and Tamil Nadu) and cities (Madras, Kanpur, Lucknow, and Ahmedabad) have a high per capita generation rate. This can be because to the dense population, fast economic development, and good quality of life in certain states and cities. Other states and cities, such as “Nagpur, Pune, and Indore, have a low per capita generation rate. These include Meghalaya, Assam, Manipur, and Tripura”. (Mani, & Singh, 2016).

MSW characteristics and composition

Important considerations in the development, implementation, and maintenance of waste management systems are the type and amount of MSW. The content and hazardous character of MSW in India differs significantly from that in Western countries. According to Kumar et al. (2017), the main components of municipal solid waste (MSW) at both the source and the point of collection are organic materials (40-60%), followed by ash and fine earth (30-40%). Paper (3-6%) and other materials (less than 1% each) make up minor percentages. A lower calorific value of 800 to 1000 kcal/kg is normal, with a carbon-to-nitrogen (C/N) ratio of 20 to 30. Physical features of MSW in cities show how density affects these types of waste. Compostable materials and inerts make up the bulk of MSW in cities, while agricultural operations and other factors cause organic waste to make up a larger proportion of MSW in rural areas. Nevertheless, rag pickers continue to play a role in the waste management process by sorting and collecting materials at different stages, which contributes to the low proportion of recyclables (Ghatak, 2016). The significance of sustainable practices and resource recovery programs is highlighted by these findings, which also highlight the necessity for regionally specific waste management methods that take MSW composition and characteristics into consideration.

Storage and collection of MSW

Most Indian cities do not have dedicated MSW storage facilities; instead, residents utilize the same containers for biodegradable and non-biodegradable trash. Corporations and municipalities are mostly responsible for collecting municipal solid waste (MSW), which frequently results in the establishment of unlawful open collection facilities in the form of communal bins along roadside. With the help of non-governmental organizations (NGOs), house-to-house collection efforts are taking shape, especially in megacities such as “Delhi, Mumbai, Bangalore, Madras, and Hyderabad”. The secondary transportation of trash cans and recycling bins to landfills is often handled by private contractors or non-governmental organizations. The efficiency of collection varies across cities and states, average around 70%. When private contractors or NGOs are involved, the efficiency is much higher. Nevertheless, a lot of cities have a hard time getting garbage collected from everywhere, especially in densely populated low-income neighborhoods where people typically dispose of their trash in a disorganized manner because they are either illegal immigrants or can't afford the service. Half of the municipal solid waste (MSW) is collected manually, while trucks collect 49%.

Table 1. Per capita generation, disposal and collection efficiency of MSW for Indian state

State	Per capita generation (g/cap/day)	Per capita disposal (g/cap/day)	Collection efficiency (%)
India (sample average)	377	273	72
Andhra Pradesh	346	247	74
Bihar	411	242	59
Gujarat	297	182	61
Haryana	326	268	82
Karnataka	292	234	80
Kerala	246	201	82
Madhya Pradesh	229	167	73
Maharashtra	450	322	72
Orissa	301	184	61
Punjab	502	354	71
Rajasthan	516	322	62
Tamil Nadu	294	216	73
Uttar Pradesh	439	341	78
West Bengal	158	117	74

Transfer and Transport

In most Indian urban areas, transfer stations are rarely used, with waste collected from individual dustbins and transported directly to processing or disposal sites. Various vehicles, including “bullock carts, tractor-trailers, and trucks, are used for transportation, with open-body trucks being common but leading to waste spillage during transport”. Collection and transportation activities typically account for 80-95% of the total MSW management budget, with municipal agencies often using their own vehicles or hiring them from private contractors. (Singh, Gupta, & Chaudhary, 2014).

Disposal and Treatment

MSW is primarily disposed of through landfilling in India, where open dumping has been identified as a significant contributor to environmental degradation in numerous cities. Composting and waste-to-energy (WTE) initiatives, including biomethanation and incineration, are nascent but encounter obstacles concerning sustainability and financial feasibility. The recycling of organic waste via aerobic composting and vermicomposting is encouraged, with the Indian government having historically supported decomposition through a number of initiatives and schemes. For energy recovery, anaerobic digestion, specifically biomethanation, is acquiring traction. Reduced utilization of incineration is a result of the high organic and moisture content of MSW. The retrieval of recyclable materials, which is predominantly carried out by informal sectors such as refuse pickers, is substantial; estimations place the recyclable content of MSW between 13 and 20%. Rag pickers are integral to the management of MSW, as they facilitate waste collection, classification, and transportation while substantially mitigating environmental expenses and challenges related to dumpsite capacity.

MSWM Rules in India

The Ministry of Environment and Forest (MoEF) issued MSW (Management and Handling) Rules in 2000 to ensure scientific MSW management, including “proper collection, segregation, transportation, processing, and disposal to prevent soil and groundwater contamination”. The Central Pollution Control Board (CPCB) monitors rule implementation, requiring municipalities to submit annual reports on MSW status. These rules apply to all Municipal Authorities in India, supplemented by state-specific Municipal Corporation Acts like the Delhi Municipal Corporation Act 1959 and Karnataka Municipal Corporation Act 1976. Acts such as the “Delhi Plastic Bag (Manufacture, Sales, and Usage) and Non-Biodegradable Garbage (Control) Act, 2000” address environmental pollution by regulating plastic bag use and non-biodegradable waste disposal. However, MSWM is often perceived as a poor service compared to other basic services, and many municipalities struggle to provide adequate conservancy services due to operational challenges and financial constraints. (Rawat, & Daverey, 2018).

Conclusion

In conclusion, public MSW separation and informal waste management networks seem more practical. People's and businesses' involvement with NGOs has the potential to increase MSWM's efficacy. The public needs to be educated about the dangers of improper waste disposal on their health and strict rules against littering are necessary. Well-designed MSW collection containers should be strategically situated for house-to-house collection. Municipalities must maintain storage facilities and transit vehicles to avoid unsanitary situations. Promote waste source segregation to improve disposal alternatives and formalize the informal recycling sector by transporting recyclables directly to recycling units. This method improves technology, conserves resources, and creates jobs. Indians choose composting and vermicomposting over incineration

due to its efficiency and environmental friendliness. Following tight MSWM guidelines, open dumping should be replaced with sanitary landfilling. The implementation gap between policy and practice shows that MSWM needs greater resource allocation, infrastructure development, and leadership. New surveys on MSW generation and characteristics are essential for informed decision-making. Improving MSWM systems in India and meeting rising service expectations requires tackling challenges such as limited financing, infrastructure, planning, and data availability.

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