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Analysis of Solid Waste Management in Chandigarh

Ar. Shashi Prakash Kushwaha, Mrs. Pooja Tandel

Abstract

This research paper provides a comprehensive overview of waste management practices in Chandigarh, India. It synthesizes findings from multiple studies focusing on municipal solid waste management, sustainability approaches, methane emissions, and waste-to-energy potential. The paper highlights challenges, current methodologies, and recommendations for improving waste management systems in the city. Solid waste studied in this present work comprises of both organic and inorganic waste. Different disposal techniques were evaluated and main approach in this study is to identify the most efficient and sustainable solution for the disposal of solid waste. Waste management services involve the activities and actions required to manage waste from collection to its final disposal.

Introduction

Chandigarh, a Union Territory and capital of two states in India, faces significant challenges in managing municipal solid waste due to rapid urbanization and population growth. Effective waste management is crucial for environmental sustainability and public health. This paper summarizes key research studies to provide insights into existing practices and future directions.

Classification of Solid Waste

1. Residential: Includes waste generated in household units, such as food and fruit peels, rubbish, ashes etc.

2. Industrial: Has two components ;Hazardous, which is toxic; corrosive; flammable; a strong sensitizer or irritant and may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed. Non-hazardous which includes

inert and essentially insoluble industrial solid waste, usually including, but not limited to, materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable

3. Commercial: Waste produced by wholesale, retail or service establishments, such as restaurants, stores, markets, theaters, hotels and warehouses.

4. Institutional: Waste that originates in schools, hospitals, research institutions and public buildings.

5. Construction and demolition: Waste building material and rubble resulting from construction, remodeling, repair, and demolition operations on houses, commercial buildings, pavements and other structures

6. Municipal services: Sludge from a sewage treatment plant which has been digested and dewatered and does not require liquid handling equipment etc.

7. Process: Treatment plant wastes principally composed of residual sludge and

8. Agricultural: Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes.

Category	Description	Examples
Biodegradable Waste	Organic matter that decomposes naturally	Food scraps, vegetable peels, garden waste, paper
Non-Biodegradable Waste	Materials that do not decompose easily	Plastics, metals, glass, packaging materials
Hazardous Waste	Waste posing risk to health/environment	Chemicals, paints, batteries, e-waste, biomedical waste
Recyclable Waste	Materials that can be processed and reused	Newspapers, cardboard, plastics, metals
Inert Waste	Construction and demolition debris	Bricks, concrete, stones, dust
Domestic Hazardous Waste	Household items with toxic properties	Expired medicines, cleaning agents, sanitary waste
Industrial Waste	Waste from factories and workshops	Sludge, scrap metals, process residues

Literature Review

Several studies have examined waste management in Chandigarh. Gupta & Gupta (2015) discussed strategies for sustainable cities, emphasizing segregation and recycling. Rana et al. (2021) assessed the efficiency of the current system, highlighting gaps in collection and disposal. Balyani et al. (2021) proposed decentralized waste treatment for sustainability. Mor et al. (2024) analyzed methane emissions from landfills and evaluated economic feasibility for waste-to-energy generation.

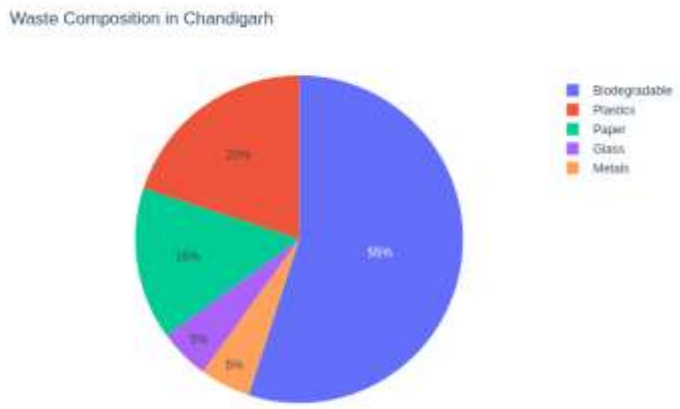
Municipal solid waste management strategies in Chandigarh

Chandigarh was formed as a union territory in 1966, and such functions as water supply, sewerage, storm water drainage, city roads and solid waste management were the responsibility of the respective departments of Chandigarh's administration. The Municipal Corporation was formed in 1994 and took on the function of solid waste management in the municipal area; beyond that central area it is carried out by the Department of Rural

Development. Besides this, the Chandigarh Pollution Control Committee is responsible for managing hazardous waste and biomedical waste.

Quantity of solid waste generated

The total waste generated in Chandigarh is calculated by the municipality to be around 135,050 metric tonnes annually (370 metric tonnes per day), or around 355 grams per person daily. There are no data on the quantity generated by different sources; however, informal discussions revealed that about two-thirds of the waste generated is from domestic sources and about one-third from non-domestic sources. The actual quantity of waste generated is greater than the amount calculated by the Municipal Corporation, which measures waste at transfer stations and processing and disposal sites. These measurements do not include waste disposed of in unauthorized places or recovered by informal waste collectors from the streets, bins and intermediate transfer points.(6) A large share of non domestic waste such as paper, plastic and tins is collected by the informal.



Solid waste collection and storage

The waste collection and storage services in Chandigarh can be broadly divided into primary and secondary collection.

Primary collection refers to the process of collecting waste from households, markets, institutions and other commercial establishments and taking it to transfer stations or directly to the disposal site, depending on the size of the city and the waste management system.

Secondary collection includes the transfer of waste from the community bins, waste storage depots or transfer stations to waste processing sites or to the final disposal site. In Chandigarh, the garbage of the SSKs is transported to the garbage processing plant and rejected waste is further transported to the landfill site for final disposal. There are different mechanisms for the collection of different types of wastes. The waste of big hotels, vegetable markets and villages is collected by Municipal Corporation trolleys and transported directly to the landfill site. Slaughterhouse waste is used at the slaughterhouse itself in its biomethanation plant. Horticultural waste in the form of dead leaves and other debris is collected by tractor trolleys hired by the Municipal Corporation and transported to the garbage processing plant. The lifting of garbage is mainly mechanical, except in places where garbage is scattered around or for the collection of dry leaves and horticulture waste.

Solid waste transportation :- Transportation of waste depends upon such factors as the type of waste, the number and type of vehicles, their capacity and the number of trips they can make in a day. In Chandigarh, the waste from dustbins and primary collection centres (SSKs) is transported to either the garbage processing plant or the landfill site by way of tractors, dumper placers (skip loaders), refuse collection compactors, open trucks, hired tractor trolleys and three-wheelers (Table 2). These vehicles are owned by the Municipal Corporation or hired from private bodies. The transportation vehicles need to be maintained in good order to be able to transport waste efficiently. The survey undertaken with Chandigarh's solid waste management officials indicates that, on average, about 10 per cent of vehicles are out of order at any given point. As the Municipal Corporation does

not have its own workshop, vehicle maintenance is done in private workshops. Officials said that while an in-house government workshop would facilitate more rapid and reliable

TABLE 2
Transportation vehicles for solid waste management in Chandigarh (2013–14)

Type of vehicle	No. of units	Capacity (metric tonnes)	Average no. of trips per day	Total waste transported daily (metric tonnes)
Trolley	50	800 kilograms	3	30
Dumper placer	52	900 kilograms	6	300
Refuse collection compactor	4	1,600 kilograms	2	4
Tractor (to pull trolley)	50	–	–	–
Tractor with front loader	4	–	–	–

SOURCE: Municipal Corporation, Chandigarh.

Method of waste disposal In Chandigarh, multiple disposal methods are used for various types of wastes. Of the 370 metric tonnes of waste that are generated each day, 125 metric tonnes (33.7 per cent) are disposed of through landfill. The landfill site, developed in Dadumajra Village, is about 45 acres in size, 25 acres of which have been filled, levelled and reclaimed in accordance with the Central Pollution Control Board's guidelines. This site is partially fenced and partially surrounded by a brick boundary wall. There is one heavy chain bulldozer (BD-50) for compacting, pushing and levelling the garbage in low-lying areas on the landfill site, a JCB (backhoe loader) for digging fresh soil, and two trucks and two tippers for transporting soil and other inert material to lay over garbage, a process that happens daily. Pipelines have been laid and a leachate collection tank constructed to collect leachate from the landfill area. There is no provision for the collection of the methane gas generated since this is not considered commercially viable.

Key Findings

1. Chandigarh generates approximately 450–500 tons of municipal solid waste daily.
2. Segregation at source remains inadequate, leading to inefficiencies in recycling.
3. Landfills contribute significantly to methane emissions, posing environmental hazards.
4. Decentralized composting and waste-to-energy projects show promise for sustainable management.

Challenges

1. **Segregation at source**: Residents separate biodegradable, non-biodegradable, and hazardous waste before disposal.
2. **Door-to-door collection**: Municipal Corporation ensures daily collection across residential, commercial, and institutional areas.
3. **Material Recovery Facilities (MRFs)**: Established to process recyclables and reduce landfill dependency.

4. **Home composting initiatives**: Encouraged through 100-liter bins, targeting biodegradable waste reduction.
5. **Integration of informal waste pickers**: Formalized roles provide dignity, stable income, and social security.
6. **Sanitation ranking**: Chandigarh secured 11th position among 4,500 urban local bodies in the 2023 survey.
7. **Enforcement measures**: Penalties imposed for littering, plastic use, and non-segregation (₹500–₹20,000).

TABLE 3
Details of garbage generated/processed per day in Chandigarh (2013–14)

Description	Quantity (in metric tonnes)
MSW generated	approx. 370
Garbage sent to plant	approx. 280
Garbage directly sent to landfill site	approx. 90
Quantity of rejected waste sent from garbage plant to landfill site	approx. 35
Total garbage sent to landfill site	approx. 125

SOURCE: Municipal Corporation, Chandigarh.

Recommendations

Segregation at source: Intensify awareness campaigns and enforce compliance so households consistently separate biodegradable, recyclable, and hazardous waste.

1. **Expand composting facilities**: Promote household and community-level composting hubs to handle the city's large share of biodegradable waste.
2. **Strengthen Material Recovery Facilities (MRFs)**: Upgrade MRFs with modern sorting technologies to maximize recycling and reduce landfill dependency.
3. **Formalize informal waste pickers**: Continue integrating waste pickers into the formal system, ensuring stable jobs, healthcare, and social security.
4. **Introduce waste-to-energy projects**: Explore sustainable energy recovery from non-recyclable fractions to reduce landfill pressure.
5. **Digital monitoring systems**: Use GPS-enabled vehicles and dashboards to track collection efficiency and optimize routes.
6. **Strict enforcement and penalties**: Maintain fines for littering, plastic use, and non-segregation, while coupling enforcement with education.
7. **Community participation**: Foster citizen involvement through awareness drives, school programs, and resident welfare associations.
8. **Plastic reduction strategies**: Strengthen bans on single-use plastics and encourage alternatives like cloth or biodegradable bags.
9. **Capacity building for staff**: Train municipal staff and sanitation workers in modern waste handling and safety practices.

Conclusion

Chandigarh has made significant progress in establishing a structured solid waste management system, with emphasis on **segregation at source, door-to-door collection, and recycling through Material Recovery Facilities**. The city's initiatives, including **home composting, integration of informal waste pickers, and strict enforcement of sanitation rules**, have positioned it among the better-performing urban local bodies in India, reflected in its **11th rank in the 2023 national sanitation survey**.

However, challenges remain in ensuring **consistent citizen compliance, scaling composting infrastructure, and managing the growing volume of daily waste (550–680 tonnes)**. Moving forward, Chandigarh must adopt a **multi-pronged approach**—combining **policy enforcement, technological innovation, and community participation**—to achieve its vision of a **zero-waste, sustainable, and inclusive city**.

Ultimately, effective solid waste management in Chandigarh is not just a technical necessity but a cornerstone of **urban governance, environmental sustainability, and public health**, requiring continuous collaboration between the **Municipal Corporation, citizens, and stakeholders**.

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