



Urbanization and Solid Waste Management: Emerging Challenges and Sustainable Practices in India

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Abstract

Urbanization has emerged as a key feature of the twenty-first century, contributing to economic development of the economy, industrial growth and development, technological advancement and improved standard of living of people in urban area. However, due to rapid urban growth and development resulted in a substantial increase in solid waste generation, creating a major concern with regard to environmental, social, and public health challenges. This study examines the concept, importance, impacts, challenges and management practices of solid waste management in urban areas of India. The research adopts a qualitative approach based on secondary data collected from textbooks, research articles, review papers, government reports, websites, and other published sources. The study highlights major issues such as inadequate waste segregation, insufficient infrastructure, financial constraints, increasing landfill pressure, environmental pollution, and health risks related with improper waste disposal. It also discusses recent regulatory developments, including the Solid Waste Management Rules, 2026, and the role of Bulk Waste Generators in promoting responsible waste handling. Further, the study highlights sustainable strategies such as source segregation, recycling, composting, waste-to-energy technologies, scientific landfills, public participation, and circular economy practices. The findings suggest that effective solid waste management requires coordinated efforts from government agencies, local bodies, private organizations, and citizens to ensure environmental sustainability and improve urban quality of life.

Keywords: Circular Economy, Environmental Sustainability, Landfills, Recycling, Solid Waste Management, Source Segregation, Urbanization, Waste Management

Introduction

Urbanization is a vital trend of the 21st century leading to significant transformations in population dynamics, economic activities, and environmental challenges. Due to urbanization cities are come across increased waste production in urban area. Urbanization is one of the major trends in this era with cities expanding day by day drastically due to migration of people from rural to urban areas. Urbanization and modernization led to economic development and improved standard of living of the people but it also generates significant challenges, among which solid waste management is particularly critical.

Waste Management refers to the collection, transportation, treatment, recycling, and disposal of all types of waste.

Types of Waste Management are as follows:

- Solid Waste Management
- Hazardous Waste Management
- Construction & Demolition Waste Management
- Liquid Waste Management
- Plastic Waste Management
- Biomedical Waste Management
- E-Waste Management
- Radioactive Waste Management

Solid Waste Management (SWM) is a part (sub-category) of Waste Management.

Solid Waste Management (SWM) is an integral component of Waste Management that focuses on the regular collection, segregation, transportation, processing, recycling, and disposal of all solid wastes generated from residential, commercial, institutional, and industrial sources.

Solid Waste Management specifically deals with solid wastes such as:

- Household garbage
- Food waste
- Glass
- Plastics
- Garden waste
- Paper and cardboard
- Metals

Solid waste management (SWM) is one of the major pressing urban challenges faced worldwide. It has been noted that, billions of tonnes of waste are generated, and much handled poorly, dumped in open areas, burned without following proper controls, or buried in overflowing landfills. The consequences are very severe which includes polluted air, contaminated water, degraded land, and a growing burden of disease. The increasing volume and complexity of solid waste generated in urban areas have overwhelmed existing waste

management systems, especially in developing countries. Solid waste includes household waste, industrial waste, used clothing and textiles, footwear and shoes, construction debris, wooden furniture waste, rubber products, metal cans, plastic bags, biomedical waste, and electronic waste, all of which require different handling, treatment, and disposal methods. The study adopts a multidisciplinary approach, combining theoretical insights, and policy analysis to offer a holistic perspective. This article presents a comprehensive overview of the solid waste management in Urban area in India, analyzing the importance, the key challenges, existing practices and advocating the adoption of sustainable solutions to address this complex issue

Conceptual Framework

Urban areas are characterized by dense populations, varied economic activities, and high consumption levels, all of which contribute to more waste generation. The waste management process usually involves several stages, including generation, segregation, collection, transportation, treatment, and disposal. However, inefficiencies at any stage can interrupt the system. In most of the cities, mainly in developing countries, waste management systems are underdeveloped and unable to cope with growing waste bulks. Rapid in the population, changing consumption patterns, and more use of non-biodegradable materials have intensified the issues. The poor urban planning and lack of infrastructure availability further complicate waste management efforts. The composition of waste has also changed over time. While traditional waste streams were largely organic and biodegradable, modern waste includes plastics, electronic waste, glass, rubber, metals, and hazardous materials, which require specialized treatment. This shift has increased the complexity and cost of waste management.

The solid waste management (SWM) challenges rapid urbanization as the primary driver, escalating waste volumes (household waste, glass, food, metals, plastic, e-waste, and etc) beyond infrastructure capacity, triggering institutional failures, financial shortfalls, infrastructural barriers, and technological gaps. This creates cascading environmental issues such as (methane emissions), health (disease vectors), and economic (lost recycling value) impacts, particularly affecting informal workers and urban poor. The solid waste management (SWM) sustainable interventions like spanning smart digital systems (IoT/AI), circular economy practices (reuse/recycling), financing, and inclusive governance—interrupt this cycle, fostering resource recovery, emission reductions (20-40%), and employment opportunity while building climate-resilient waste systems. Analogous to innovation systems theory, the outline emphasizes stakeholder collaboration (government-private-community) for adaptive, long-term urban sustainability.

Review of Literature

Tchobanoglous et al. (1993) highlighted that integrated solid waste management systems combining waste reduction, segregation, recycling, and scientific disposal are more effective than conventional waste management practices. Mani et al. (2017) detected that public awareness is vital and environmental education play a crucial role in improving waste segregation and sustainable waste disposal practices. Cointreau (2006) stated that private sector participation enhances operational efficiency and service delivery in urban waste management systems. Wilson, Velis, and Cheeseman (2006) recognized the contribution of the informal recycling sector in resource recovery and waste reduction in developing countries. Mandpe et al. (2022) advocated the adoption of circular economy principles to transform waste into valuable and usable resources and promote sustainability. Kumar et al. (2025) highlighted rapid urbanization, inadequate infrastructure, and weak implementation of regulations as major barriers to effective waste management in Indian cities. Patil, Patil, and Patil (2025) stressed the importance of integrated waste management, public participation, and investment in waste management infrastructure. Collectively, these studies indicate that sustainable solid waste management requires technological innovation and expansion, policy support, stakeholder

collaboration, and community participation. The review of literature further suggests that a comprehensive and integrated approach is important for addressing the growing challenges of urban solid waste management.

Research Gap

The existing studies have examined the waste generation, recycling practices, and policy rules and regulations. However, very limited attention has been given to the combined bearing of rapid urbanization, emerging regulatory reforms, and sustainable waste management practices in the Indian. This study attempts to find and fill this gap by providing a comprehensive review of contemporary challenges and sustainable solutions for urban solid waste management.

Research Methodology

This study adopts a qualitative research approach based on secondary data sources such as textbooks, websites, research papers, review papers, newspapers, government reports, market research reports, environmental impact assessment reports, and etc. focusing on urban solid waste challenges and solutions.

Objectives of the Study

1. To study the impact of urbanization on solid waste generation in India.
2. To examine the major challenges in implementation of urban solid waste management practices.
3. To assess the implication of SWM Rules 2026 and the duties of Bulk Waste Generators.
4. To study the adverse effects of improper solid waste management
5. To know the important aspects of solid waste management
6. To examine the Problems in the Implementation of Solid Waste Management Practices
7. To identify sustainable practices for effective solid waste management.

Limitations of the study

- This study relies only on the secondary data.
- The research focuses on urban areas and does not include rural waste systems.
- The study is restricted to solid waste management only.

Solid Waste Management Rules, 2026

The rules are notified by the Ministry of Environment, Forest and Climate Change on 27th January 2026, and effective from 1st April 2026.

Mandatory Four-Stream Segregation of Solid waste at source

Mandatory source segregation into distinct streams to maximize recovery and ensure scientific disposal processes.



Figure 1: Mandatory Four-Stream Segregation of Solid waste at source

Regulatory Framework

Governing urban and rural local bodies with a responsibility for infrastructure deployment and compliance reporting.

Extended Bulk Waste Generator Responsibility

Extended Bulk Waste Generator Responsibility certificates generated against waste processing.

In Solid Waste Management (SWM), a Bulk Waste Generator (BWG) can be a person, organization, institution or establishment which generate a large quantity of solid waste on every day basis and they are responsible for processing and managing its waste at source.

A Bulk Waste Generator (BWG) is a building or establishment having a floor area of 20,000 square metres or more, consuming 40,000 litres of water per day, and generating 100 kg or more of solid waste per day.

Categories of Bulk Waste Generators (BWGs)

Bulk Waste Generators are categorized into three major categories such as institutional, Commercial, and Residential establishments based on its waste generation and nature of their activities.

1. Institutional BWGs

- Government Departments (Central/State)
- Local Bodies and Government Offices

- Public Sector Undertakings (PSUs)
- Private Corporate Offices
- Colleges and Universities
- Community Facilities and Public Buildings
- Schools
- Other Educational and Research Institutions
- Other

2. Commercial BWGs

- Railway Stations and Railways
- Bus Stations and Depots
- Hotels
- Ports and Harbours
- Airports
- Industrial Areas and Industrial Parks
- Multiplexes, Cinema Halls, and Multi-level Parking Facilities
- Shopping Malls and Commercial Complexes
- Restaurants and Food Courts
- Marriage and Banquet Halls
- Wholesale Markets and Mandis
- Community Halls
- Meat and Fish Markets
- Stadiums
- Sports Complexes
- Convention Centres, Auditoriums, and Clubs
- Conference Centres
- Expo and Exhibition Centres
- Tourist Places and Tourist Spots
- Other

3. Residential BWGs

- Residential Societies
- Resident Welfare Associations (RWAs)

- Other

Biodegradable/ Wet Waste	Non-biodegradable / Dry/ Recyclable Waste	Domestic Hazardous Waste
<ul style="list-style-type: none"> • Kitchen Waste including: tea leaves, egg shells, fruits and vegetable peels • Meat and Bones • Garden and Leaf litter, including flowers • Soiled paper • House dust after cleaning • Coconut shells • Ashes 	<ul style="list-style-type: none"> • Newspaper • Paper, books and magazines • Glass • Metal objects and wire • Plastics • Cloth Rags • Leather • Rexene • Wood/Furniture • Polystyrene/ Packaging material 	<ul style="list-style-type: none"> • Aerosol cans • Batteries • Bleaches and household kitchen and drain cleaning agents and its container • Car batteries, oil filters and car care products and consumables • Chemicals and solvents and their container • Cosmetic items, chemical based insecticides and their containers • Paints, oils, lubricants, glues, thinners, and their container • Pesticides and herbicides and their container • Photographic audio/video tapes and their containers, • chemicals • Styrofoam and soft foam packaging of furniture, packaging and equipment • Thermometers and mercury-containing products • Discarded medicine and disposable syringes

Lists not exhaustive

Annexure 1: Examples of waste types

Duties of Bulk Waste Generator as per SWM Rules, 2016

- a) Segregate and store the waste generated in three separate streams namely – (i) bio-degradable (wet waste); (ii) non-biodegradable (dry waste); and (iii) domestic hazardous wastes in suitable bins/containers. Details of various components of municipal solid waste categories in above three categories can be seen at Annexure-1.
- b) Process wet waste (Bio-degradable waste) to the extent feasible in premises itself and develop a system of reuse of products of processing, that is, compost or biogas etc.
- c) Handover segregated dry wastes to Urban Local body (ULB) waste collector or agency authorized by ULB to collect waste on its behalf as per the direction or notification by the local authorities from time to time.
- d) Handover segregated domestic hazardous wastes to authorized waste pickers or waste collectors as per the direction or notification by the local authorities from time to time.
- e) Wrap securely the used sanitary waste like diapers, sanitary pads etc., in the pouches provided by the manufacturers or brand owners of these products or in a suitable wrapping material as instructed by the local authorities (such as newspaper, paper etc.) and handover separately to waste collector or place the same in the bin meant for dry waste or non-bio-degradable waste.
- f) Store horticulture waste and garden waste generated from premises separately in own premises and carry out composting in compost pits within the premises. In case of non-availability of land, dispose off as per the directions of the urban local body from time to time.
- g) Store separately Construction & Demolition waste generated in own premises and dispose off as per the Construction & Demolition Waste Management Rules, 2016.

h) In addition to above, bulk waste generators are required not to mix E-waste – it should be separately stored as and when generated and should be handed over to recycling chain.

Important Aspects of Solid Waste Management

1. Due to population growth, industrialization and urbanization the amount of waste is increasing worldwide. There is a need for effective solid waste management to maintain public health, environmental quality and sustainable development.
2. Segregation is the foundation of an effective solid waste management system. Waste should be separate into biodegradable, non-biodegradable, and hazardous categories at generation. Proper segregation of solid waste improves recycling and reduces the burden on landfills.
3. To maintain cleanliness and prevent environmental pollution it is important to have a well-organized system for waste collection, transportation, treatment, and final disposal of solid waste in urban area.
4. It is vital to have a proper solid waste management system. Improper waste disposal can pollute soil, water, and air. Effective solid waste management helps prevent pollution, conserves natural resources, and protects ecosystems from harmful effects.
5. Proper and efficient solid waste management reduces health risks such as infections, respiratory problems, and the spread of communicable diseases.
6. Modern sanitary landfills are planned with systems for leachate collection, gas control, and environmental protection. Proper landfill management extends landfill life and reduces environmental damage.
7. The principles of 3Rs i.e. Reduce, Reuse, and Recycle are vital to sustainable waste management. These practices aid reduction waste generation, conserve resources, and reduce disposal costs.
8. Landfill burden can be reduced by converting organic waste into useful products through composting, vermicomposting, and anaerobic digestion.
9. Materials such as paper, plastic, glass, and metals can be recycled and reintroduced into the production cycle. Recycling conserves raw materials and lessens environmental impacts.
10. The success of solid waste management rest on the participation of citizens, institutions, industries, and local authorities. Public awareness about solid waste management and responsible behavior are essential for effective waste segregation and disposal.
11. Modern solid waste management emphasizes resource recovery, recycling, and reuse rather than disposal. A circular economy approach transforms waste into valuable resources and promotes long-term sustainability

Adverse Effects of Improper Solid Waste Management

Improper solid waste management is known to have a plethora of environmental impacts, but apart from that, it also has health and financial impacts.

1. Improper SWM basically affect the health of people who are involved with waste collection such as waste disposal workers, rag pickers, and people living & working in the nearby areas. The experience to toxic gases, or harmful chemicals can lead to various infections, skin irritation, and respiratory issues.
2. Due to improper or delayed solid waste management disposal by authorities, the waste piles and emit foul smell and attracts insects and stray dogs which becomes a problem for the society at large.

3. When organic waste breaks down, it makes a harmful liquid called leachate that can seep into the soil and groundwater. This leachate is filled of pollutants and can mix with toxic chemicals, making the problem worse. If not managed properly, this can permanently damage our soil and water resources.
4. Due to improper disposal of organic waste leads to rotting in unhygienic conditions and attracts pests and becomes their breeding ground. Such pests become vectors for disease-carrying germs present in the waste that can lead to an epidemic outbreak.
5. Consumption of plastic or any toxic garbage can lead to death of people, amongst stray animals and birds. Chemicals out through leachate can travel to nearby waterways and can be toxic to aquatic life. Gases from waste can release toxic gases which are hazardous, corrosive, and a bane to all living organisms.

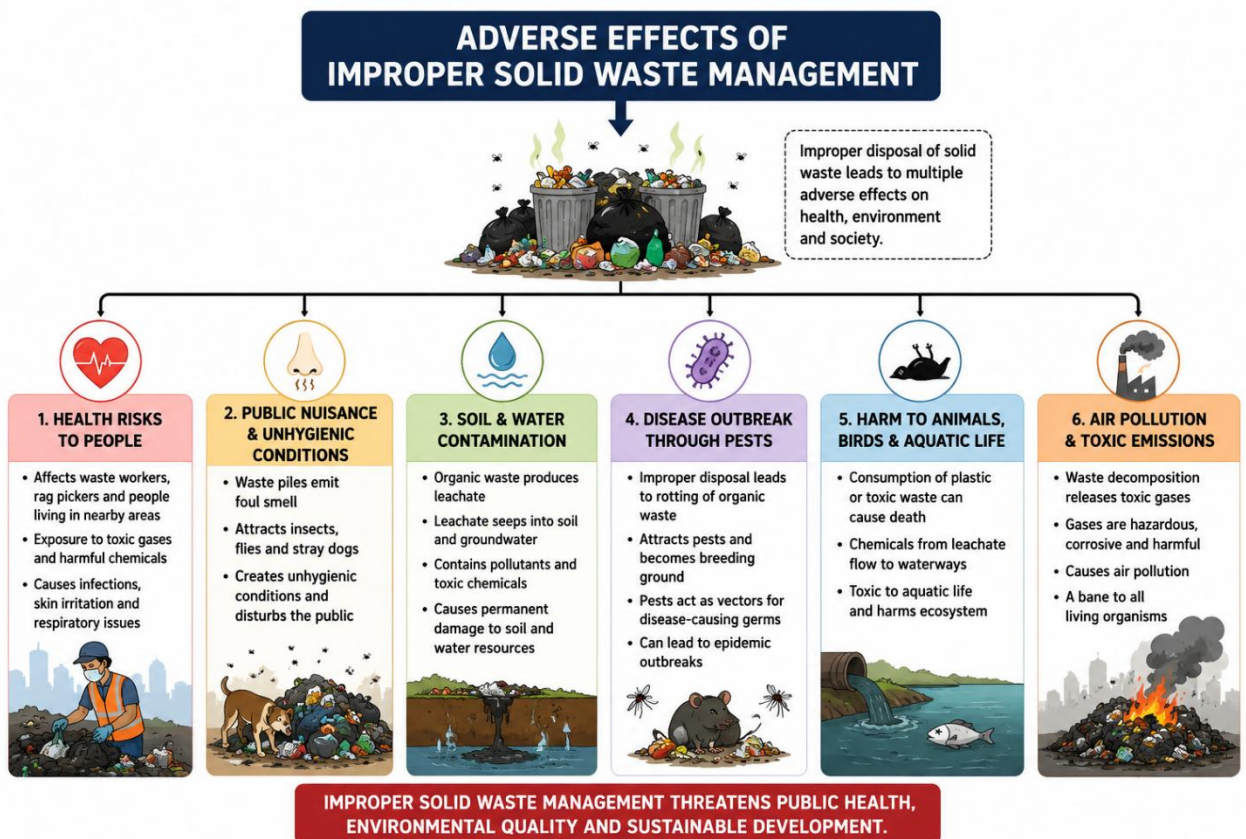


Figure 2: Adverse Effects of Improper Solid Waste Management

Problems in the Implementation of Solid Waste Management Practices

1. Rapid population growth, urbanization, and industrialization generate large quantities of waste every day. Many households and establishments do not segregate wet, dry, and hazardous waste properly.
2. In many areas, waste collection is irregular and there is lack of transportation facilities. People often lack knowledge about proper waste disposal and recycling practices.

3. Municipal bodies regularly face lack of funds for waste management infrastructure and operations. Finding suitable land for landfills and treatment facilities is becoming increasingly very difficult.
4. The present landfill sites are reaching their maximum capacity due to continuous waste dumping. Many of the cities lack proper and sophisticated facilities for recycling and resource recovery.
5. Composting plants, and waste-to-energy facilities are insufficient to handle the total waste generated in urban areas. Due to which the improper disposal of waste causes air, water, and soil pollution.
6. Improper management of waste attracts pests, insects, and disease-causing organisms, creating public health risks.
7. Hazardous waste, e-waste, and biomedical waste are often mixed with municipal waste, making treatment very difficult.
8. Many local bodies face shortages of educated and trained personnel and modern waste management technologies. Moreover, the existing rules and regulations are not always effectively implemented and monitored.
9. Active involvement of citizens is important for successful waste management which is often lacking. Moreover, collection of waste, treatment and disposal requires continuous investment and maintenance.
10. Many people are not willing to adopt waste reduction, segregation, and recycling practices. Unscientific dumping methods and open burning of waste continue in several areas, causing environmental and health problems.

Solutions for Effective Solid Waste Management

1. It is vital to encourage households and institutions to separate wet, dry, and hazardous waste. It is important to conduct awareness campaigns, workshops, and educational programs on solid waste management.
2. It is important to ensure regular and efficient door-to-door waste collection services. It is also crucial to establish more recycling centers.
3. It is important to promote household and community composting of biodegradable waste. Use waste-to-energy plants, and advanced recycling technologies.
4. Develop scientific sanitary landfills with proper leachate and gas management systems and allocate sufficient funds for waste management projects and infrastructure.
5. Implement waste management rules strictly and impose penalties on households, institutions and commercial for violations. It is very important to encourage people to lessen waste generation and reuse materials whenever possible.
6. Create awareness and involve residents, NGOs, educational institutions, and local organizations in solid waste management activities. Provide technical training to municipal workers and waste handlers.
7. Establish separate collection and disposal methods for hazardous waste and electronic waste. Encourage collaboration between government agencies and private organizations for efficient solid waste management.

8. It is vital to promote eco-friendly alternatives and minimize plastic consumption. Use digital tools and regular inspections to track waste collection, treatment, and disposal.
9. Convert biodegradable waste into useful products such as compost, biogas, recycled materials, and energy.
10. It is vital to encourage responsible purchasing habits and reduce unnecessary consumption among people.

Discussion

Despite the presence of waste management policies, and rules and regulatory frameworks, significant implementation gaps continue to hinder for the effective implementation of solid waste management in urban areas. waste segregation rates remain low due to inadequate public awareness, inadequate education and training, irregular collection practices, limited participation of people, lack of incentives, and insufficient monitoring mechanisms. Local bodies often struggle with financial deficit, limited technological adoption, shortage of trained personnel, operational and maintenance challenges, and inadequate infrastructure for waste collection, treatment, and disposal. Rapid urbanization and increasing waste generation further intensify these challenges, placing additional pressure on existing systems. The findings indicate that technological innovation, stronger institutional capacity, and community engagement are essential for improving solid waste management outcomes. In the future, adopting circular economy principles and strengthening stakeholder collaboration can contribute to sustainable, resilient, and environmentally responsible urban solid waste management systems.

Conclusions

Rapid urbanization, population growth, and industrial development have significantly increased the generation of solid waste in urban areas. Effective solid waste management is important for protecting public health, protecting environmental quality, and supporting sustainable urban development. The study highlights that improper waste handling leads to pollution, health hazards, and depletion of natural resources. Source segregation, recycling, composting, and scientific disposal methods are crucial for efficient waste solid management. The implementation of updated regulatory frameworks and the active participation of citizens, institutions, commercial establishments and local bodies can improve solid waste management outcomes. Adequate infrastructure, technological support, and public awareness are necessary to overcome existing challenges. Adopting the principles of reduce, reuse, and recycle can minimize waste generation and promote resource conservation. Therefore, a coordinated and sustainable approach to solid waste management is essential for creating cleaner, healthier, and environmentally responsible urban communities.

.Declaration of Conflicting Interests

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