

THE STATE OF SOLID WASTE MANAGEMENT IN URBAN INDIA: CHALLENGES AND THE WAY FORWARD

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Abstract: The rapid urbanization and economic growth in India have resulted in a significant increase in municipal solid waste generation, posing major challenges to urban local bodies. Effective solid waste management is crucial in cities with high population densities, where inadequate waste disposal can lead to environmental and health hazards. This paper examines the current status, problems, and challenges of solid waste management in urban India, highlighting the need for sustainable and scientific waste management practices

Keywords: Solid waste management, Urban India, Municipal solid waste, Sustainable waste management, Urbanization

INTRODUCTION

Solid waste management (SWM) is a significant challenge in urban India. Rapid urbanization and population growth have increased solid waste generation, placing pressure on the existing waste management infrastructure. This analysis aims to identify the challenges of solid waste management (SWM) in urban India and provide relevant data to support the discussion. In the urbanization process, there is a considerable movement of people from rural to urban areas. The United Nations perceives urbanization as a movement of people from rural to urban areas.

NEED OF THE STUDY

With rapid urbanization and rising population densities, Indian cities are generating unprecedented volumes of municipal solid waste, overwhelming the capacity of urban local bodies. Despite policy interventions such as the Solid Waste Management Rules, 2016, ground-level implementation remains weak due to inadequate infrastructure, financial constraints, poor source segregation, and low public participation. The resulting accumulation of waste leads to serious environmental degradation, public health hazards, and inefficient use of resources. While several studies have examined solid waste management in specific cities, there is a need for a comprehensive understanding of the current status, systemic challenges, and gaps across urban India. This study is therefore essential to identify key bottlenecks, evaluate existing practices, and suggest practical measures for sustainable and scientific waste management in urban areas.

Review of literature:

Daisy Das and Ratul Mahanta (2011), in the paper entitled ‘Municipal Solid Waste Management in Guwahati: A Case Study,’ mentioned the challenges of solid waste management in Guwahati City. The authors claim that, although the Guwahati Municipal Corporation is the responsible authority for dealing with the city’s solid waste, the services of the Corporation are neither efficient nor sufficient. So, the paper reviews people’s willingness to pay to mitigate critical issues. The authors express their concern about the

harmful impact of solid waste on humans and the environment, and the demand for positive efforts by the Guwahati Municipal Corporation.

MA Hutson (2011) in the paper entitled 'Urban Sustainability and Community Development: Creating Healthy Sustainable Urban Communities' underscores critical issues confronted by urban communities, specifically in the United States such as land use, transportation, infrastructure, and scarcity of low-cost housing facilities, etc. These elements adversely affected the common life of low-class people. The paper recommended that urban planners and policymakers should give due attention to sustainable urban development so that a healthy atmosphere can be generated for the community for urban living.

M Docio, A Dunarintu (2012), in the paper entitled 'The Socio-Economic Impact of Urbanization,' present a comprehensive panoramic view of urbanization, defining it as the population growth in urban centers resulting from the drainage of people from the rural landscape. It addresses the multi-dimensional effect of urbanization through social, economic, and ecological perspectives. It spotlights the multiple aspects of urbanization and its relevance in developing countries.

Lakhimi Gogoi (2013) in the paper entitled 'Municipal Solid Waste Disposal: A Case Study in Guwahati City to Mitigate the Man-Made Disaster' reviews the various types of solid waste generated in Guwahati City and how the residents are responsible for it. The paper mentioned that increased economic activities and rapid urbanization are the main driving forces for municipal solid waste in Guwahati. The paper recommended adopting scientific approaches on the part of the authority and active participation by all stakeholders to mitigate the issue and achieve sustainable development.

T. Dinesha (2017) in the paper 'Urban Solid Waste Management in India: Present Challenges and Future Prospects' analyze the problem of solid waste management in urban India and tries to provide a rational policy to improve solid waste management in urban areas. The author emphasized adequate policy implication in the form of proper classification, segregation, and disposal of solid waste along with environmentally friendly urban growth in India.

S. Chaturvedi and A. Khare (2022) in the paper 'Solid Wastes: Characteristics, Composition and Adverse Effect on Environment and Public Health' evaluate the main sources, reasons, features, and categories of solid waste along with its adverse effects on human beings and the ecosystem. It focuses on the crucial role of effective solid waste management practices in mitigating environmental contamination and health risks, etc.

P Theodorou (2022) in the paper entitled 'The Effect of Urbanization on Ecological Interactions' makes a comprehensive assessment of the urban ecosystem highlighting how urban growth affects interspecies interactions, which is significant for recognizing urban ecological degradation. It recognizes the realistic mechanical system by which urban ecology changes can modify both antagonistic and mutualistic interactions among species.

AR Rashed (2023) in the book chapter entitled 'The Impact of Unsustainable Urbanization on the Environment' advocates that urban settings are not only for human congregation but also imperative for economic productivity, a center of socio-cultural exchange, and sustainable development. In the article, the author highlights the diverse benefits of sustainable urbanization, such as opportunities for employment generations, optimal utilization of land resources, and optimizing infrastructural functionality. It recognizes the adverse effects of unsustainable urban processes in the form of sound pollution, air pollution, water pollution, and decay of ecological balance, etc, signaling the urgency of sustainable development in the context of the 2030 Agenda for Sustainable Development.

R Govindaraj et al. (2023) in the paper entitled 'Environmental Protection and Urbanization Process in Developing Nations: An Assessment of International Efforts and its Implications' focus on the challenges

of urbanization in developing countries, specifically in the context of environmental protection. It accentuates the necessity for a deeper understanding of urban settings and the outcomes of mass migration in urban areas. It demands a new definition of urbanization which may protect the interests of the ecosystem. The paper connects urbanization with the promotion of sustainability in the form of eco-friendly energy consumption, etc. Besides, it also recommended the policy framework to safeguard against the adverse effects of urbanization on the ecosystem.

S Prakash (2024), in the paper entitled ‘Sustainable Solid Waste Management in India Towards 2030,’ raised serious concerns about solid waste management practices in India. It provides a careful analytical evaluation of the ongoing nature and management of solid waste in India, covering the dimensions of generation, waste composition, collection methods, segregation, and disposal.

Theoretical framework

The study is based on the Integrated Sustainable Waste Management (ISWM) framework, which explains solid waste management outcomes as a function of three key variables:

1. Institutional Capacity (Independent Variable) – refers to the financial resources, infrastructure, manpower, and enforcement capability of Urban Local Bodies (ULBs).
2. Stakeholder Participation (Independent Variable) – refers to the involvement of households (segregation at source), the informal sector (recycling), and private operators in the waste chain.
3. Policy Implementation (Moderating Variable) – refers to the effectiveness of Solid Waste Management Rules, 2016, in bridging the gap between policy and practice.

Dependent Variable: Effectiveness of Solid Waste Management (ESWM) – measured through indicators such as waste collection efficiency, segregation rate, recycling rate, and reduction in landfill dependency.

The framework posits that the effectiveness of solid waste management in urban India is determined by institutional capacity and stakeholder participation, moderated by the degree of policy implementation. Weakness in any of these variables leads to unsustainable waste management outcomes.

Research Methodology

The present study is descriptive and analytical in nature. It seeks to examine the current state, challenges, and policy gaps in solid waste management in urban India. The study is entirely based on secondary data collected from various authentic and published sources, including: Reports of the Ministry of Housing and Urban Affairs (MoHUA), Government of India, Central Pollution Control Board (CPCB) annual reports on solid waste management, Swachh Bharat Mission (Urban) documents, Census of India data, Research articles, journals, and books related to urban waste management. Newspaper articles and websites of Urban Local Bodies (ULBs)

Objectives

1. To identify the major challenges faced by urban India in managing solid waste
2. To analyze the impact of ineffective solid waste management on the environment and public health.
3. To examine the existing policies and regulations governing solid waste management in urban India
4. To identify best practices and strategies for effective solid waste management
5. To suggest recommendations for improving solid waste management in India.

It is generally claimed that urbanization boosts economic development. The pace of urbanization and economic expansion is reciprocal. Urbanization typically leads to enhanced productivity, as cities provide greater access to resources, labor, and markets, which catalyzes economic growth. On the contrary, economic development entices more people to the towns, enriching urbanization. It leads to a virtuous cycle where each process becomes self-reinforcing by supporting the others, particularly in developing countries where urban centers become a hub of industrialization and innovation. The urbanization process is now becoming a global phenomenon. It is mainly attributed to the rapid growth of the population, falls in livelihood potentialities in rural areas, the modern lifestyle of the urban, and the transition from the low-income primary sector to the high-paid secondary and tertiary sectors.

According to the most recent data from the UN, 55% of people on Earth currently reside in cities, and by 2050, that number is predicted to rise to 68%. The steady movement of people from rural to urban regions, known as urbanization, along with the global population expansion, is predicted to result in an additional 2.5 billion people living in urban areas by 2050. According to the 2018 Revision of World Urbanisation Prospects, which was created by the UN Department of Economic and Social Affairs (UN DESA) Population Division, by 2050, future increases in the global urban population are anticipated to be concentrated in a small number of nations and 35% of the anticipated expansion of the urban population will come from China, Nigeria, and India combined. India is expected to have 416 million more urban dwellers by 2050, followed by China with 255 million and Nigeria with 189 million.

Between 1950 and 2018, the world's urban population increased from 751 million to 4.2 billion. This trend is expected to continue, with the urban population more than doubling its current size by 2050, at which point nearly 7 of 10 people will live in cities. With more than 80% of global GDP generated in cities, urbanization can contribute to sustainable growth through increased productivity and innovation if managed well. However, the speed and scale of urbanization bring challenges, such as meeting accelerated demand for affordable housing, and viable infrastructure, including transport systems, basic services, and jobs, particularly for the nearly 1 billion urban poor who live in informal settlements near opportunities. Rising conflicts contribute to pressure on cities as more than 50% of forcibly displaced people live in urban areas.

Once a city is built, its physical form and land use patterns can be locked in for generations, leading to unsustainable sprawl. The expansion of urban land consumption outpaces population growth by as much as 50%, which is expected to add 1.2 million km² of new urban built-up area to the world by 2030. Such sprawl puts pressure on land and natural resources, resulting in undesirable outcomes; cities represent two-thirds of global energy consumption and account for more than 70% of greenhouse gas emissions.

The growth of urbanization in India is basically through two ways: one is through an increase in the urban population, which will be natural, and the second one is through migration, which is the result of people migrating from rural to urban areas and also from small towns/cities to big metros. However, in the 1990s, i.e., when the Indian government opened up its economy, there was a rise in the country's rapid economic growth. However, this economic growth was more of urban growth, which led to the rapid migration of the rural population to urban areas.

Decadal Urban Population and its Percentage and Growth

Year	Urban Population (million)	Percentage of Urban to Total Population	Decadal Growth Rate (percent)
1901	25.4	10.8	-
1911	25.8	10.9	1.6
1921	28.7	10.9	11.2
1931	31.7	11	10.4
1941	34.8	11.1	9.8
1951	42.2	17.3	21.3
1961	62.5	22.6	48.3
1971	78.9	25.7	26.2
1981	104	23.6	31.7
1991	217.5	25.7	109.5
2001	285.4	27.8	31.2
2011	377.1	31.2	32.2

Source: Census of India data

The decadal urban population is a particular area that lives in urban or metropolitan areas and is counted every ten years. In India, the decadal urban population is the population living in urban areas as per the government's census conducted every ten years. Based on the tabular data, India's urban population has grown quickly over the last century, with the proportion of urban to total population rising from 10.8% in 1901 to 34.0% in 2021. The decadal growth rate has likewise risen, with a maximum rate of 109.5% recorded between 1981 and 1991. This reflects the rapid urbanization that has occurred in India during the last few decades.

Solid waste covers discarded materials that the owner or user no longer requires. Solid waste includes materials that are in a solid or liquid state but excludes wastewater and small particulate matter released into the atmosphere (United Nations, 2014).

Solid waste management (SWM) is one of the key responsibilities of city administrators and a key indicator of effective governance. Effective SWM mitigates adverse health and environmental impacts, conserves resources, and improves the liveability of cities. However, unsustainable SWM practices, exacerbated by rapid urbanization and financial and institutional limitations, negatively impact public health and environmental sustainability. The disposal methods are predominantly via uncontrolled dumping, open-air incinerators, and landfills. The negative impacts of such practices include air and water pollution, land degradation, methane emissions, hazardous leachate, and climate change. These impacts impose significant environmental and public health costs on residents, with marginalized social groups mostly affected.

Waste Generation Trends in India

YEAR	Per Capita Waste Generation gm/day	Total Urban Municipal Waste Generation MT/yr
1971	375	14.9
1981	430	25.1
1991	460	43.5
1997	490	48.5
2025 (Estimated)	700	57.0

Source- India Energy Portal

Challenges of Solid Waste Management in Urban India

Waste Management is now a problem not only in urban areas but also in semi-urban and rural areas. Waste lying on roadsides, low-lying areas, and vacant places, outside drainages, etc. not only mars the aesthetic beauty of that place but is a serious health and environmental hazard to the people. Animals feeding on this waste and consuming all polythene and hazardous waste mixed with kitchen waste is a serious health hazard for them. Though solid waste management now exists in metropolitan cities, it is far from being available in semi-urban and rural areas, creating environmental and health hazards to the residents of those areas. Major challenges associated with the solid waste management (SWM) system in India can be highlighted as under

Rapidly increasing population and waste respectively: According to the UN's World Population Dashboard, India's current population stands at 1.428 billion, which was 1.21 billion (census 2011), and is rapidly increasing. Newly urbanized areas and semi-urban areas are already feeling the burden of population, and accordingly, civic services and waste management is coming as a challenge in these areas. There is no system of Integrated Waste Management (ISWM) here, and waste is increasing day by day with an increase in population and an increase in per capita waste generation rate due to changing lifestyles, an increase in income, and consumerism

1. Inadequate Waste Collection and Transportation: In many urban areas, waste collection and transportation services are inadequate, leading to overflowing garbage bins and littered streets. According to a Ministry of Housing and Urban Affairs report, only 70-80% of the waste generated in urban areas is collected, leaving a significant portion uncollected (MoHUA, 2019).

2. Lack of Proper Waste Segregation: Waste segregation is not practiced effectively in many urban areas, sending mixed waste to landfills or dumpsites. A study by the Centre for Science and Environment found that only 12% of the households in Delhi segregate their waste (CSE, 2019). In India, all waste, whether it is biodegradable, recyclable, construction, hazardous, or soiled, is mixed. No system of segregation at the source level exists here. Though in rural areas earlier it was practiced that kitchen waste was used to feed the animals but with increasing income, changing lifestyles, and use of more packaging and plastic material all waste is mixed now and put into one dustbin which makes the problem of waste management more complex.

3. Insufficient Waste Treatment and Disposal Facilities: Urban India lacks sufficient waste treatment and disposal facilities, leading to the dumping of waste in landfills or dumpsites. According to a report by the Central Pollution Control Board, only 15% of the waste generated in urban areas is treated, while the remaining 85% is dumped in landfills or dumpsites (CPCB, 2019).

4. Financial Constraints: Municipal corporations in urban India face financial constraints in implementing effective SWM systems. A study by the National Institute of Urban Affairs found that the average expenditure on SWM in urban India is only ₹150-200 per capita per year, which is insufficient to implement effective SWM systems (NIUA, 2019).

5. Lack of Public Awareness and Participation: Public awareness and participation are crucial for effective SWM. However, many urban residents are not aware of the importance of proper waste disposal and segregation. A survey by the Ministry of Housing and Urban Affairs found that only 30% of the respondents in urban areas were aware of the importance of waste segregation (MoHUA, 2019).

6. Inadequate Institutional Framework: The institutional framework for SWM in urban India is inadequate, with multiple agencies involved in waste management, leading to a lack of coordination and accountability. A report by the World Bank found that the lack of a clear institutional framework for SWM is a major constraint in implementing effective SWM systems in urban India (World Bank, 2019).

7. Lack of Planning: In India, there is no law regarding waste disposal and treatment of residential areas/apartments/flats at the time of passing the plan of these areas where their waste will be disposed of and how it will be treated. Private developers take benefit of this and no place in residential areas is left for disposal and treatment of waste. The result is that their waste scatters here and there at any vacant place or plots or alongside roads. Even newly developed cities are finding it difficult to get a landfill place to dump the waste of the city.

8. Lack of Resources: As civic bodies give very low priority to SWM, accordingly, very little budget is assigned for it. Whatever funds are assigned, they are only for waste collection and transportation and not for treatment or recycling. According to one estimate, 90% of the total fund is assigned for collection and the rest for transportation; no funds are left for the treatment of waste.

Recommendations for effective SWM in urban India:

Implement Waste Segregation

Waste segregation involves separating waste into different categories, such as organic, inorganic, and hazardous waste. This separation makes it easier to recycle, compost, or dispose of waste in an environmentally friendly manner. Effective waste segregation requires proper infrastructure, including separate bins for different types of waste, and public awareness campaigns to educate citizens on the importance of segregation.

Promote Recycling

Recycling involves converting waste materials into new products, reducing the need for raw materials, and minimizing waste sent to landfills. Recycling programs can be implemented for various materials, including paper, plastic, glass, and metal. Effective recycling programs require proper infrastructure, including recycling facilities and collection systems, as well as public awareness campaigns to encourage participation.

Reduce Single-Use Plastics

Single-use plastics, such as straws, bags, and water bottles, contribute significantly to plastic waste and pollution. Reducing single-use plastics requires implementing policies and regulations, such as bans or levies, and promoting the use of alternative materials, such as cloth bags and stainless-steel water bottles. Public awareness campaigns can also play a crucial role in educating citizens about the harmful effects of single-use plastics and promoting behavioral change.

Compost Organic Waste

Organic waste, such as food waste and yard trimmings, can be composted and converted into nutrient-rich soil. Composting reduces the amount of waste sent to landfills, minimizes greenhouse gas emissions, and creates a valuable resource for agriculture and gardening. Effective composting programs require proper infrastructure, including composting facilities and collection systems, as well as public awareness campaigns to encourage participation.

Door-to-Door Collection

Door-to-door waste collection involves collecting waste directly from households and institutions. This approach ensures that all households and institutions participate in waste management and reduces the likelihood of waste being dumped illegally. Effective door-to-door collection requires proper infrastructure, including waste collection vehicles and personnel, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Designate Waste Collection Zones

Designating waste collection zones involves dividing cities or towns into specific areas for waste collection. This approach ensures that waste is collected regularly and systematically, reducing the likelihood of waste accumulation and environmental pollution. Effective waste collection zones require proper infrastructure, including waste collection vehicles and personnel, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Use GPS-Enabled Vehicles Using GPS-enabled vehicles for waste collection involves tracking waste collection vehicles in real time to optimize routes and collection schedules. This approach ensures that waste is collected efficiently and effectively, reducing fuel consumption and greenhouse gas emissions. Effective GPS-enabled vehicles require proper infrastructure, including GPS tracking systems and waste collection vehicles, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Provide Adequate Waste Storage Facilities

Providing adequate waste storage facilities involves ensuring that waste is stored safely and securely, preventing overflow and environmental pollution. Effective waste storage facilities require proper infrastructure, including waste storage containers and facilities, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Set Up Waste-to-Energy Plants

Waste-to-energy plants involve converting waste into energy through incineration or gasification. This approach reduces the amount of waste sent to landfills, minimizes greenhouse gas emissions, and generates electricity. Effective waste-to-energy plants require proper infrastructure, including waste-to-energy facilities and energy generation systems, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Develop Sanitary Landfills

Sanitary landfills involve disposing of waste in a controlled and regulated manner, minimizing environmental pollution and public health risks. Effective sanitary landfills require proper infrastructure, including landfill liners, leachate collection systems, and gas management systems, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Implement Bio-methanation

Bio methanation involves converting organic waste into biogas through anaerobic digestion. This approach reduces the amount of waste sent to landfills, minimizes greenhouse gas emissions, and generates renewable energy. Effective bio methanation requires proper infrastructure, including anaerobic digesters and biogas generation systems, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Encourage Decentralized Waste Management

Decentralized waste management involves managing waste at the local level, reducing the need for long-distance waste transportation, and promoting community involvement. Effective decentralized waste management requires proper infrastructure, including local waste management facilities and community education programs, as well as public awareness campaigns to educate citizens on the importance of proper waste disposal.

Conclusion:

Solid waste management is a significant challenge facing urban India. Inadequate waste collection and transportation, lack of proper waste segregation, insufficient waste treatment and disposal facilities, financial constraints, lack of public awareness and participation, and inadequate institutional framework are some of the major challenges facing SWM in urban India. To address these challenges, municipal corporations should invest in improving waste collection and transportation services, promote waste segregation, increase waste treatment capacity, enhance public awareness and participation, and strengthen the institutional framework for SWM.

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