

Solid Waste Management and Environmental Sustainability in Urban Areas

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Abstract

Rapid urbanisation, rising incomes and changing consumption patterns have increased the quantity and complexity of municipal solid waste in Indian cities. When this waste is not collected, segregated, treated and disposed of scientifically, it pollutes air, soil and water, emits greenhouse gases, spreads disease and damages the urban environment, which makes solid waste management an essential condition for environmental sustainability. This paper examines the status of solid waste management in urban India on the basis of secondary data from the Central Pollution Control Board, replies of the Ministry of Housing and Urban Affairs in Parliament, and published research. Three comparison tables are prepared: year-wise generation of municipal solid waste, the progress in the share of waste processed over time, and a comparison of the fate of waste in 2020-21 in terms of the quantity treated, landfilled and unaccounted. The analysis shows that urban India generates about 1.6 lakh tonnes of solid waste per day, that about 95 per cent of it is collected, and that the reported share of waste processed increased from less than 24 per cent in January 2018 to 75 per cent in the latest government reply. However, the independent annual report of the pollution control board shows that only about half of the generated waste was treated in 2020-21 and that nearly 32 per cent remained unaccounted, which means that it was disposed of in an unscientific manner. The paper concludes that sustainability of cities depends on source segregation, decentralised processing, scientific landfills, remediation of old dumpsites, integration of the informal sector and reliable monitoring of data.

Keywords: Solid Waste Management, Urban Areas, Environmental Sustainability, Source Segregation, Landfill, Waste Processing, Swachh Bharat Mission

Introduction

Municipal solid waste is the waste generated by households, markets, commercial establishments, institutions and street sweeping in urban areas, and it includes food waste, paper, plastic, glass, metal, textiles and other items. The quantity of waste rises with population, income and urbanisation. Hoornweg and Bhada-Tata estimated in their global review that cities of the world were generating about 1.3 billion tonnes of solid waste per year, and that the figure would rise to about 2.2 billion tonnes by 2025, with the largest increase in the cities of developing countries (Hoornweg and Bhada-Tata 7). A later estimate by Kaza and co-authors placed global waste generation at about 2.01 billion tonnes in 2016 and projected an increase to about 3.40 billion tonnes by 2050, and it noted that at least one-third of the waste is not managed in an environmentally safe manner (Kaza et al. 3). Hoornweg, Bhada-Tata and Kennedy concluded that waste production would not peak during this century unless there are major changes in consumption and policy (Hoornweg et al. 615). Chen and co-authors also found that the growth in municipal solid waste is concentrated in lower income regions where collection and treatment systems are weak (Chen et al. 3).

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India is part of this trend. Its cities are expanding quickly, and the composition of waste is changing toward more packaging and plastic as incomes grow. Narayana argued that Indian cities have to move from a model of simple collection and disposal to a model of resource recovery, in which waste is treated as a source of compost, materials and energy (Narayana 1164).

The legal framework in India is provided by the Solid Waste Management Rules, 2016, notified by the Ministry of Environment, Forest and Climate Change, which replaced the earlier Municipal Solid Wastes Rules of 2000. The rules require waste generators to segregate waste at source into wet, dry and domestic hazardous categories, make local bodies responsible for door-to-door collection and processing, and apply the principle that the polluter pays (Ministry of Environment, Forest and Climate Change 6). They also extend the coverage beyond municipal limits to urban agglomerations, census towns, airports, railways and similar areas.

The Swachh Bharat Mission (Urban) supports the implementation of the rules with funds, technical guidance and citizen awareness. Its second phase, launched on 1 October 2021 for five years, aims at garbage-free cities through 100 per cent source segregation, door-to-door collection and scientific management of all fractions of waste, including safe disposal in scientific landfills (Ministry of Housing and Urban Affairs 8). The Central Pollution Control Board monitors the implementation by collecting annual reports from the states, and the data of these reports form the basis of this paper (Central Pollution Control Board 4).

Environmental sustainability means meeting the needs of the present without damaging the ability of the environment to support future generations. Solid waste management influences sustainability in several ways. Open dumping and unscientific landfills produce leachate that contaminates groundwater and surface water, and the decomposition of organic waste produces methane, a powerful greenhouse gas. The IPCC assessment attributed a few per cent of global greenhouse gas emissions to the waste sector, mainly because of methane from landfills and wastewater (Bogner et al. 590). Burning of waste releases particulate matter and toxic pollutants, and uncollected waste blocks drains, increasing urban flooding and the breeding of disease vectors.

The issue is also part of the global development agenda. The Sustainable Development Goals include a target to reduce the adverse per capita environmental impact of cities by paying special attention to waste management (target 11.6), and a target to substantially reduce waste generation through prevention, reduction, recycling and reuse (target 12.5) (United Nations 25). Scheinberg, Wilson and Rodic proposed the integrated sustainable waste management framework, which looks at the whole system, namely the physical elements such as collection, recycling and disposal, and the governance aspects such as inclusivity, financial sustainability and sound institutions (Scheinberg et al. 30).

Objectives, Scope and Significance of the Study

1. To explain the nature of the urban solid waste problem and its environmental implications.
2. To analyse the generation of municipal solid waste in India.
3. To compare the progress in waste processing over time.

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4. To compare how generated waste is treated, landfilled, or left unaccounted for.

Review of Literature

The literature is reviewed under three heads: status and problems of waste management in Indian cities, approaches and technologies, and sustainability and institutions.

Gupta and co-authors described the situation of solid waste in Indian cities in the nineties and identified weak collection, lack of segregation, open dumping and shortage of land as the main problems, and they suggested options such as composting and recycling (Gupta et al. 140). Sharholi and co-authors reviewed municipal solid waste management in Indian cities and found that collection efficiency was low, that waste composition had a high share of organic matter, and that most cities used uncontrolled dumping, with weaknesses in finance, technology and public participation (Sharholi et al. 461). Kumar and co-authors assessed the situation in metro cities, state capitals and other towns and reported wide differences between city classes in collection, transport and disposal practices (Kumar et al. 885). Annepu studied the sector in the context of waste-to-energy and observed that the share of waste that is actually processed in the country was low and that most cities depended on landfilling and dumping (Annepu 24). Joshi and Ahmed reviewed the status and challenges and listed unscientific disposal, lack of segregation, inadequate funding and poor enforcement as persistent problems (Joshi and Ahmed 5). Kumar and others later identified the lack of source segregation, financial constraints and the weak integration of waste pickers as major obstacles (Kumar et al. 3).

Troschinetz and Mihelcic studied recycling in developing countries and concluded that economic, institutional and social factors, including participation of the informal sector and public awareness, determine its success (Troschinetz and Mihelcic 918). Singh and co-authors examined the potential for generating energy from municipal solid waste in India and found that technologies such as incineration, biomethanation and refuse derived fuel are possible but are limited by the composition of waste, which has high moisture and low calorific value, and by the cost (Singh et al. 4800). Bogner et al. pointed out that diversion of organic waste from landfills, landfill gas recovery and recycling are important measures to reduce methane and other emissions (Bogner et al. 590).

Wilson and colleagues compared solid waste management in twenty cities using a set of indicators and showed that good performance is associated with strong governance and financial arrangements, and not only with technology (Wilson et al. 240). Wilson, Velis and Cheeseman examined the informal sector and showed that waste pickers contribute substantially to recycling and the reduction of the burden on municipalities, but they work in poor and unsafe conditions (Wilson et al. 800). Scheinberg et al. recommended an integrated approach that links technical, financial, social and institutional aspects (Scheinberg et al. 30).

The literature shows that the problem is well recognised and that solutions are known, but that implementation is weak. There are fewer studies that compare official figures of processing progress with independent assessment, and this is attempted in the present paper.

Research Methodology

The study is descriptive and analytical and uses only secondary data. Data on the quantity of municipal solid waste generated in 2018-19, 2019-20 and 2020-21 were taken from the reply of the

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Government of India in the Lok Sabha on municipal waste treatment. The information on the share of waste processed at different dates was taken from the replies of the Ministry of Housing and Urban Affairs in Parliament. The data on the quantity of waste collected, treated, landfilled and unaccounted in 2020-21 were taken from the Annual Report on Implementation of the Solid Waste Management Rules, 2016 prepared by the Central Pollution Control Board. Percentage change, share in total generation and the gain in percentage points over a base date were calculated to make the data comparable. Annual quantities in million tonnes were obtained by multiplying the daily figures by 365. All figures are rounded, and the latest official figures should be checked before reuse.

Data Analysis and Discussion

Table 1 shows the daily quantity of municipal solid waste generated in urban India in three financial years, with the equivalent annual quantity and the change over the previous year.

Table 1: Generation of Municipal Solid Waste in Urban India (2018-19 to 2020-21)

Financial Year	Waste Generated (tonnes per day)	Equivalent Annual Quantity (million tonnes)	Change over Previous Year (%)
2018-19	1,52,076.70	55.5	-
2019-20	1,50,761.00	55	-0.9
2020-21	1,60,038.90	58.4	6.2

Source: Government of India, Lok Sabha reply on Municipal Waste Treatment (quantum of waste generated, 2018-19 to 2020-21); annual quantity and change calculated by the author.

Urban India generated about 1.5 lakh tonnes of solid waste per day in 2018-19 and 2019-20, and the figure rose by 6.2 per cent to about 1.6 lakh tonnes per day in 2020-21, which is about 58 million tonnes in a year (Government of India, Lok Sabha Reply 2). About 95.4 per cent of the waste was reported to be collected in 2019-20 (Government of India, Lok Sabha Reply 2). The slight fall in 2019-20 can be linked with the slowing of economic activity, and the rise in 2020-21 may reflect improved reporting and the growth of the urban population, as well as more packaging waste from home delivery during the pandemic. The data do not allow a firm explanation. The important point is that the quantity of waste is large and is increasing, so the system must keep expanding just to maintain the existing level of service. This is consistent with the global projections of Kaza et al. and Chen et al., which show that waste generation grows with urbanisation and income (Kaza et al. 3; Chen et al. 3).

Progress in Processing of Waste: Government Reports

Table 2 compares the share of waste reported as processed by the Ministry of Housing and Urban Affairs at four points of time, from the period before the second phase of the Swachh Bharat Mission to the latest available position.

Table 2: Comparison of Share of Municipal Solid Waste Reported as Processed at Different Dates

Position as on	Waste Generated (tonnes per day)	Waste Processed	Share Processed (%)	Gain over January 2018
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		(tonnes per day)		(percentage points)
31-Jan-18	About 1,43,000	33,800	23.73	-
31-Dec-18	1,45,687	73,121	50.19	26.5
Jun-19	About 1,45,000	Not given	54	30.3
Dec-22	1,52,245	1,14,183	75	51.3

Source: Replies of the Ministry of Housing and Urban Affairs in Parliament (Rajya Sabha 2018; Lok Sabha Unstarred Question No. 250 of 5 February 2019; Lok Sabha 2019; Lok Sabha 2022); gains calculated by the author. *Derived by applying the reported percentage to the quantity generated.*

According to the Ministry, the share of waste processed more than tripled in five years, from 23.73 per cent in January 2018 to 75.0 per cent in the latest reply, while the quantity of waste generated increased only modestly from about 1.43 lakh to about 1.52 lakh tonnes per day (Ministry of Housing and Urban Affairs, Rajya Sabha Reply 1; Ministry of Housing and Urban Affairs, Lok Sabha Reply 6; Ministry of Housing and Urban Affairs, Lok Sabha Reply 4).

The largest jump took place between January and December 2018, when the reported share doubled, a change that coincides with the intensification of the Swachh Bharat Mission and with improved reporting by urban local bodies. This improvement is a positive sign and it reflects the creation of composting, material recovery and waste-to-energy facilities. At the same time, the increase has to be read carefully, because the figures are reported by the local bodies and the definition of processing may vary between states.

Fate of Urban Solid Waste in 2020-21: Independent Assessment

The annual report of the Central Pollution Control Board gives a more detailed account of what happens to the generated waste. Table 3 compares the quantity collected, treated, landfilled and unaccounted in 2020-21 and expresses each as a share of waste generated and, where relevant, of waste collected.

Table 3: Comparison of Collection, Treatment, Landfilling and Unaccounted Waste in 2020-21 (CPCB)

Category	Quantity (tonnes per day)	Share of Waste Generated (%)	Share of Waste Collected (%)
Waste generated	1,60,038.90	100	-
Waste collected	1,52,749.50	95.4	100
Waste treated	79,956.30	50	52.3
Waste landfilled	29,427.20	18.4	19.3
Unaccounted waste (disposed unscientifically)	50,655.40	31.7	-

Source: Central Pollution Control Board, Annual Report on Implementation of Solid Waste Management Rules, 2016 (2020-21); shares calculated by the author.

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The CPCB data show that collection is relatively good, with about 95 per cent of the waste collected, but treatment is much lower. Only about half of the generated waste, or 79,956 tonnes per day, was treated, and about 18.4 per cent was landfilled. The remaining 50,655 tonnes per day, equal to 31.7 per cent of all waste, was not accounted for as treated or landfilled, which indicates that it was dumped or burnt in an unscientific manner or was left uncollected (Central Pollution Control Board 4). The three categories of treated, landfilled and unaccounted waste add up to the total generated waste. When this table is compared with Table 2, a gap becomes visible. The Ministry's latest figure of 75 per cent processed is much higher than the 50 per cent treated in the independent report, even though the two refer to different periods and definitions. The difference suggests that a part of the waste reported as processed may be handled by informal or partial methods, or that reporting is more optimistic. It also underlines the need for transparent and standardised data, which is a basic requirement of the integrated approach described by Scheinberg et al. (Scheinberg et al. 30). Unaccounted waste of this size means continued leachate, methane emission and open burning, which weakens the contribution of waste management to environmental sustainability (Bogner et al. 590).

Major Findings

The study offers the following findings. First, urban India generated about 1.6 lakh tonnes of municipal solid waste per day in 2020-21, which is about 58 million tonnes a year, and the quantity rose by 6.2 per cent over the previous year. Second, the collection system is comparatively strong, since about 95 per cent of waste is collected, but the processing system is weak. Third, the Ministry reports that the share of waste processed increased from 23.73 per cent in January 2018 to 75 per cent in December 2022, which shows significant policy effort. Fourth, the independent assessment of the pollution control board shows that only about 50 per cent of the generated waste was treated in 2020-21, 18.4 per cent was landfilled and 31.7 per cent was unaccounted for, which means that a large amount of waste is still disposed of unscientifically. Fifth, the difference between the official and independent figures shows the need for reliable and standard monitoring of data.

Suggestions

Cities should make source segregation into wet, dry and hazardous waste a reality through household awareness, incentives for compliance and penalties for violation, since processing is easier and cheaper when waste is segregated at source. Decentralised processing of wet waste, through community composting and biomethanation, should be expanded, because organic waste makes up a large part of the municipal waste and its diversion from landfills reduces methane. Old dumpsites should be remediated through bio-mining, and new landfills should be built only for the residue that cannot be recycled or processed (Annepu 24). The informal sector of waste pickers should be integrated into the formal system with identity cards, fair payment, safety equipment and social security (Wilson et al. 800). Waste-to-energy projects should be set up only after considering the waste composition and costs (Singh et al. 4800). Urban local bodies should receive stable finances, technical staff and user-fee systems so that services are sustainable (Scheinberg et al. 30). Finally, a common reporting format, third-party verification and open data for all cities should be introduced so that the real progress can be tracked. Further research should compare cities of different size and study the cost and environmental benefit of different treatment options.

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Conclusion

Solid waste management is a core requirement of environmental sustainability in urban areas. The data analysed in this paper show that Indian cities generate a large and growing quantity of waste, that collection is largely in place, and that official reports indicate a rapid rise in processing since 2018. However, the independent assessment shows that only about half of the waste was treated in 2020-21 and that nearly one-third remained unaccounted. Sustainable urban waste management therefore requires a shift from collection and dumping to segregation, recovery and scientific disposal, supported by decentralised infrastructure, inclusion of waste workers, adequate finance and transparent data. If cities move in this direction, they can reduce pollution and greenhouse gas emissions, recover valuable resources and improve the health and quality of life of residents, which together give real meaning to the goals of sustainable and resilient cities.

References

1. Annepu, R. K. (2012). *Sustainable Solid Waste Management in India* (Master's thesis). Columbia University, New York.
2. Bogner, J., Ahmed, M. A., Diaz, C., et al. (2007). Waste management. In *Climate Change 2007: Mitigation of Climate Change* (pp. 585-618). Contribution of Working Group III to the Fourth Assessment Report of the IPCC. Cambridge University Press.
3. Central Pollution Control Board (2022). *Annual Report on Implementation of Solid Waste Management Rules, 2016 (2020-21)*. CPCB, Delhi.
4. Chen, D. M.-C., Bodirsky, B. L., Krueger, T., Mishra, A., & Popp, A. (2020). The world's growing municipal solid waste: Trends and impacts. *Environmental Research Letters*, 15(7), 074021.
5. Government of India. *Lok Sabha Reply on Municipal Waste Treatment: Quantum of Municipal Waste Generated, 2018-19 to 2020-21*. Parliament of India, New Delhi.
6. Gupta, S., Mohan, K., Prasad, R., Gupta, S., & Kansal, A. (1998). Solid waste management in India: Options and opportunities. *Resources, Conservation and Recycling*, 24(2), 137-154.
7. Hoornweg, D., & Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management*. World Bank, Washington, DC.
8. Hoornweg, D., Bhada-Tata, P., & Kennedy, C. (2013). Environment: Waste production must peak this century. *Nature*, 502, 615-617.
9. Joshi, R., & Ahmed, S. (2016). Status and challenges of municipal solid waste management in India: A review. *Cogent Environmental Science*, 2(1), 1139434.
10. Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. World Bank, Washington, DC.
11. Kumar, S., Bhattacharyya, J. K., Vaidya, A. N., Chakrabarti, T., Devotta, S., & Akolkar, A. B. (2009). Assessment of the status of municipal solid waste management in metro cities, state capitals, class I cities, and class II towns in India: An insight. *Waste Management*, 29(2), 883-895.
12. Kumar, S., Smith, S. R., Fowler, G., et al. (2017). Challenges and opportunities associated with waste management in India. *Royal Society Open Science*, 4(3), 160764.

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Organized by- Navyug College of Education, Hisar (16 Aug 2026)

In IJESH ISSN: 2250-3115

13. Ministry of Environment, Forest and Climate Change (2016). *Solid Waste Management Rules, 2016*. Government of India, New Delhi.
14. Ministry of Housing and Urban Affairs (2018). *Reply in Rajya Sabha on Processing of Solid Waste (position as on 31 January 2018)*. Parliament of India, New Delhi.
15. Ministry of Housing and Urban Affairs (2019). *Lok Sabha Unstarred Question No. 250 on Treatment of Waste* (answered 5 February 2019). Parliament of India, New Delhi.
16. Ministry of Housing and Urban Affairs (2021). *Swachh Bharat Mission-Urban 2.0: Operational Guidelines*. Government of India, New Delhi.
17. Ministry of Housing and Urban Affairs (2022). *Reply in Lok Sabha on Disposal of Solid Waste* (December 2022). Parliament of India, New Delhi.
18. Narayana, T. (2009). Municipal solid waste management in India: From waste disposal to recovery of resources? *Waste Management*, 29(3), 1163-1166.
19. Scheinberg, A., Wilson, D. C., & Rodic, L. (2010). *Solid Waste Management in the World's Cities*. UN-Habitat, Earthscan, London.
20. Sharholly, M., Ahmad, K., Mahmood, G., & Trivedi, R. C. (2008). Municipal solid waste management in Indian cities: A review. *Waste Management*, 28(2), 459-467.
21. Singh, R. P., Tyagi, V. K., Allen, T., Ibrahim, M. H., & Kothari, R. (2011). An overview for exploring the possibilities of energy generation from municipal solid waste (MSW) in Indian scenario. *Renewable and Sustainable Energy Reviews*, 15(9), 4797-4808.
22. Troschinetz, A. M., & Mihelcic, J. R. (2009). Sustainable recycling of municipal solid waste in developing countries. *Waste Management*, 29(2), 915-923.
23. United Nations (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*. United Nations, New York.
24. Wilson, D. C., Rodic, L., Scheinberg, A., Velis, C. A., & Alabaster, G. (2012). Comparative analysis of solid waste management in 20 cities. *Waste Management & Research*, 30(3), 237-254.
25. Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International*, 30(4), 797-808.