

# WASTE MANAGEMENT TO ACHIEVE SUSTAINABLE DEVELOPMENT GOALS: APPROACH FOR INDIAN CITIES

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**Abstract.** Solid waste management has become a serious concern for city managers and environmentalists in developing countries due to fast urbanization, unplanned development, and changing lifestyles leading to the generation of a huge amount of waste. Sustainable waste management strategies are required to handle large quantities the waste. It requires comprehensive knowledge about the different waste management strategies adopted in India as well as in other countries and to find out the scope for effective management of waste to make cities clean and livable. The paper attempts to understand the important role played by different sectors engaged in waste management who execute in response to specific contexts for efficient management. Existing waste management practices in India and other countries are reviewed and operational difficulties are identified. A pilot survey of the planned neighborhood area in the city of Cuttack is conducted to understand the ongoing practices of Solid Waste Management and also inhabitants' acceptance of waste management initiatives.

**Key words:** solid waste management, sustainable, contextual

## 1. Introduction

One of the definitions of waste is "anything that does not create value" (MHRD, 2019). Generally, any material is considered garbage when it cannot be utilized in the future. If we look in detail, nothing to be called waste, as everything has a specific use. If treated properly, all waste components can be reutilized in some way or another. Thus one can define solid waste as "organic or inorganic waste materials produced out of household or commercial activities,

that have lost their value in the eyes of the first owner but which may be of great value to somebody else (Robinson, 1986).

India is generating almost among the top 10<sup>th</sup> cities producing a considerable amount of solid waste. As per the Central Pollution Control Board report, 62 million tonnes of garbage have proceeded daily in India. More than 70% of the municipal waste remained untreated and dumped at the landfilling sites of the urban local

bodies. Continuous dumping will lead to a shortage of dumping sites (Gupta *et al.*, 1998). The organic matter present in the waste at dumpsites contributes to global warming through greenhouse gas emissions (Ahluwalia and Patel, 2018). Currently, waste management issue is at the forefront among other environmental problems. Fig. 1 is showing the waste composition characteristics in Indian cities. Most of the waste collected from the municipalities is of mixed type and the waste thrown in open areas and near to road side causes blockage of drains (Kumar and Agarwal, 2020) India has the target to achieve 100 percent cleanliness by October 2019 (Kumar *et al.*, 2017). In Indian cities per capita, the waste generation rate varies between 200 and 870 grams daily, continuously increasing (Kumar *et al.*, 2020). With increasing urbanization and population growth trends in urban areas of Indian cities, between 2001 to 2011, garbage and waste showed a fifty percent increase in generation rate (World, 2011). Many countries like Australia, Germany, and the USA have adopted innovative waste management methods. Indian cities can also adopt some of these practices, which are context specific. Lots of waste management problems such as inadequate collection bins, no sources segregation, and blockage of drains due to waste thrown by people (Kumar *et al.*, 2009).

## 2. Policy-level interventions

The first waste management rule came in the 1990s after the Supreme Court judgment. Various waste management policies and schemes that came up later are like municipal solid waste management and handling rules 2000, National urban sanitation policy 2008, and others. The Swacch Bharat Mission in October 2014 acted as a turning point for

Waste management Awareness amongst Urban Local Bodies (Asnani and Zurbrugg, 2007). Many further rules like the e-waste rules, 2011, plastic waste rules, 2011, and batterie rules, 2011 focused on specific types of waste, with waste management rules 2016 being the latest addition (MSW Rules, 2000).

Following are some of the highlights of the solid waste management rules, 2016 (Govt of India, 2016):

- i. It is a mandate for everybody to segregate the waste, but no such penalty is mentioned for those municipalities or urban local bodies who don't follow it.
- ii. It is also mentioned that a land area of more than 5000 square meters should have their waste in their land, but again, such penalties are mentioned in the rule for whosoever doesn't obey this.
- iii. It is the responsibility of the producer or brand owners to collect back the packaging waste produced during the transport of the goods.
- iv. WTE (waste-to-energy) plants should be encouraged and installed, and also all fertiliser producers must sell compost along with chemical fertilizers.

## 3. Waste management best practices over the world

United States of America (USA): Collecting Waste by Robots- The method of effective collection of waste is done by eco-friendly robotic machines which collect waste materials and debris into the inbuilt dumpster barge from the river Baltimore. It has been given the name MR. Trash Wheel. In the past three years, it could effectively segregate 1.1 million pounds of garbage from the river.

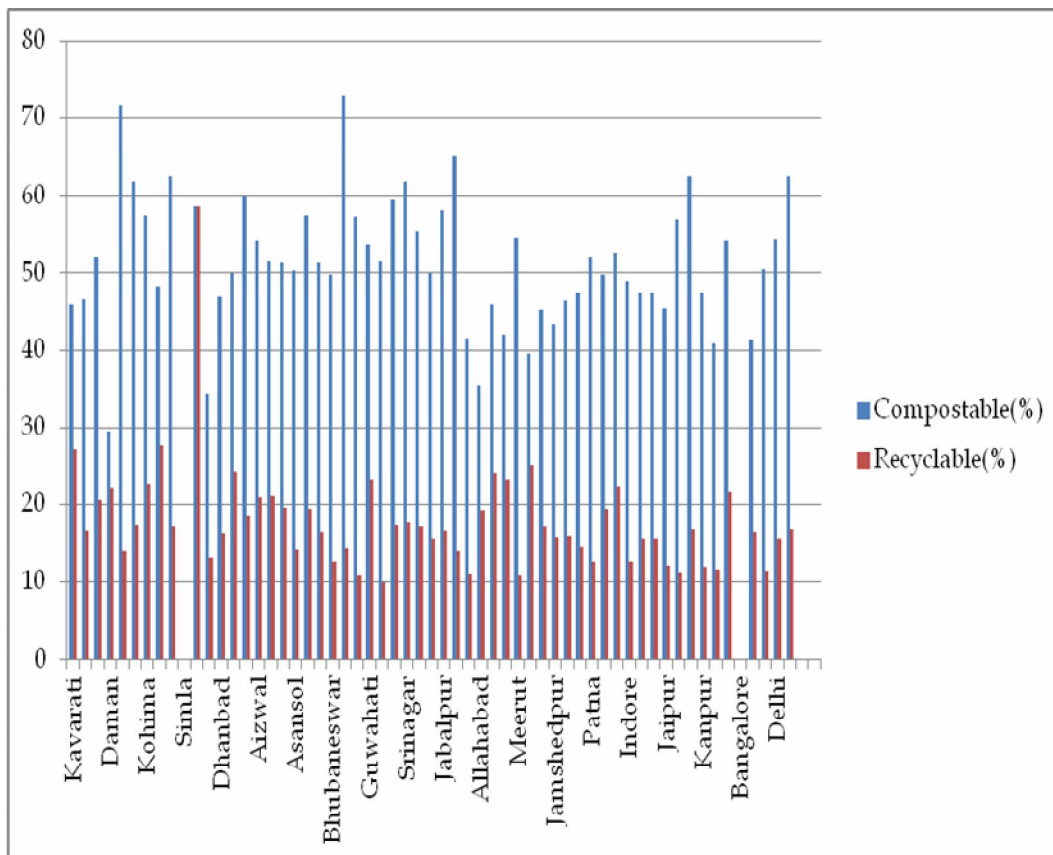


Fig. 1. Waste composition characteristics in India (Source: CPCB India).

Australia: Special bins designed for efficient waste management- SmartBelly bins are specific bins made for proper waste management in Australia. These are designed in such a way that they can create extra space to accommodate more waste when required. This method of collection can reduce collection frequency and reduce the number of trips. It also reduces the cost of transportation and lesser emission. These special bins are connected to the public bins and individual bins to help in better monitoring and management of waste (Solomon, 2011). Waste monitoring systems with artificial Intelligence methods are also effectively tracking the progress of solid waste management (Abdallah *et al.*, 2020).

Generate power through waste to energy plants: European environment agency targets to achieve a recycling rate of 50%

municipal waste. Many countries have shown achieving quite a surprising rate of the waste management target. Sweden has gained a 99% recycling rate, and only 1 % of the waste goes to landfill sites. In WTE plants, the organic wastes are converted to electric power (Chaliki *et al.*, 2014).

Germany: Biodegradable leaf plates to reduce plastic pollution- the Leaf republic is a German company that is inspired by the use of leaf-made plates in India and has started preparing biodegradable plates out of leaves which is the replacement for previously used plastic plates and has reduced considerable amount of plastic waste. Even in India, there are eco-conscious companies that prepare biodegradable and eco-friendly dishes, and in many cases, people are using reusable products to reduce plastic pollution (Song *et al.*, 2009).

Nepal, Tanzania, and Nigeria: Waste Composting and reduction of solid waste-These countries have shown sustainable waste management strategies in proper treatment of biodegradable waste through composting or anaerobic digestion collaboratively with the help of government, private sector, and local community (Kumar and Agarwal, 2020). Nigerian University campuses have shown strategies adopted in the reduction of waste at source and recovery methods (Ugwu *et al.*, 2021).

Columbia: Recycling plastic: Columbia has incorporated a very effective way of collecting plastic waste through an attractive reward system (Sasmoko *et al.*, 2022). As per the report, around 10000 tonnes of waste are being collected from the cities of Medellín, Barranquilla Bogotá, and Cali. The plastic waste collection is done by a vending machine named Ecobot, which is installed near public spaces such as shopping areas, institutions, etc., where people can deposit plastic waste, and in return for that, they can get rewards in terms of coupons of, movie tickets and shopping benefits.

#### 4. Waste management best practices in India

There are several examples where the cities have set benchmarks for innovative waste management practices. After the introduction of India's Swachh Bharat mission in 2014, Indore municipality of west-central India, although being one of the populous cities, with an effective waste collection system, source segregation, composting, and a stringent legal system coupled with multi-stakeholder participation, recognized and awarded as the cleanest city award in 2017 and continuing to be the first position till now (Truelove and O'Reilly, 2020). The ULB of Panaji city of Goa has

also developed a module that has the vision of zero landfilling through proper waste management strategies. The municipality has made different fractions of the solid waste to treat differently. The entire municipal waste of the city is divided into six bits (Goa municipality, 2001). Organic waste is composted and dry waste is sent for co-processing and other recycling practices. A stable leadership repeated campaign city-wide and on social media with a focused vision has made this module a compelling example. Many innovations in the field of waste management to tackle the challenge have helped Panaji achieve this success (Chandrappa and Das, 2012).

The municipality of a small town named Gorai, located in the northwest part of Greater Mumbai, India has also proved its efficiency in waste management (Rodic and Gupta 2012). The accumulation of the waste was at its highest capacity in the dumpsite, and the scientific closure of the dumpsite project was taken up by the municipality, which took 15 years to execute the project. Effective planning of the dumpsite through covering the waste ground with proper lining rainwater drainage, careful landscaping, and proper installation of leachate collection and flaring system. After this, the entire MSW was covered by construction and demolition waste, and the site was recovered. Through this project, an area of 19 hectares is recovered by green land, and the quality of life of the people is improved. It could provide a better aquatic environment and also reduce many hazards to accumulation of waste such as foul smell, fire, etc. (Hafidz, 2012). The Vijayawada Municipal Corporation, through a decentralized vermicomposting facility, has showcased the simple and effective management of organic waste through facilities. In this

module, a practical step by step by step method of vermicomposting technique and its maintenance along with pre and post-processes are involved. Other municipalities can easily follow the same procedure for proper biodegradable waste management. The involvement of social workers, waste collectors, nongovernment organizations, and municipality people improved the waste management system in Pune and Ahmedabad (Parhi, 2019). Pune has involved the local communities and engaged them in the segregation of waste at source (Chaliki *et al.*, 2014).

Smaller cities in India are developing better waste management mechanisms than their larger counterparts. Smaller city initiatives can be learned from bigger cities. Ambikapur, an agricultural and mineral-based city in Chattisgarh, the tourist town of Alappuzha in Kerala, and Vengurla, a coastal city of Maharashtra, are three cities that show us that innovation has nothing to do with size. Floral waste management and making useful products are one of the initiatives shown by small cities (Singh *et al.*, 2017).

Exchange Waste for a Meal in Ambikapur, Chhattisgarh: In July, Ambikapur became home to India's first garbage cafe, where people receive meals for waste. One kilogram of plastic waste can get you a full meal, whereas half a kilogram will fetch you breakfast. Additionally, the plastic collected by the Ambikapur Municipal Corporation (AMC) will be used to construct roads. While the garbage cafe is a novel idea to help clean the city, and plastic roads are a great way to use recycled plastic, this alone is not enough to help the city manage its waste (Chandrappa and Das, 2012).

In 2012 protests from residents living near a landfill in Alappuzha resulted in the shutting of the landfill two years later. The town began a pilot project in 2014, providing anaerobic composting bins and biogas plants to every family to segregate and process garbage with a 90% and 75% subsidy. The scheme expanded over time to cover most of the city. In areas where there are no household bins, residents may use community bins. This system operates at the ward level (Kumara, 2015). Recognizing the town's successful model, the Kerala State government developed a policy to install aerobic bins in 1000-gram panchayats. The decentralized system is not just finding appreciation in the state; the city of Shillong in Meghalaya also replicated it. Alappuzha's waste management system was also recognized as a success story by the United Nations Environment Program. Alappuzha was one of three cities given a clean City Award by the Centre for Science and Environment in 2016 and was the cleanest city in Kerala as per the state rankings in Swachh Survekshan 2019.

Vengurla converted a landfill into a waste management park with convenient features like fruit trees and an organic farm. Still, the main attractions include a segregation yard, a biogas plant, a plastic crusher unit, and a briquette-making plant. Regularly separates waste into 23 categories, and the park recycles almost every type of waste, including plastic, cloth, and paper. In 2017, 7000 people visited the town to see its unique park. This also generates revenue for the municipality (NITI Aayog, 2021). The architect behind the scheme attributed part of its success to public participation. Several other towns in Maharashtra have made significant strides in waste management (Randhawa *et al.*, 2020).

Table 1. Observations were taken during the survey (Source: Authors).

Factors	Relevance	Evidence	Future Implications
Concern about waste	Effect on human health and environment	As per the survey, more than 50% of the people accepted that waste has a serious effect on the surrounding environment (refer to Fig 2.)	dumping of waste in surrounding areas should be restricted
Waste composition	Biodegradable and nonbiodegradable waste	The majority of the people accepted that more than 50% of the waste is biodegradable waste (refer to Fig. 3.)	Decentralized Composting pits can be planned for the community
Waste segregation	Household-level Municipal level	Still, 40% of people are not segregating waste at the household level (refer to Fig. 4).	Strict rules need to be implemented
Reward system	Tax benefit or reduction in water and electricity bill	More than 90% respondents are willing to do waste segregation if a reward system will be applied (refer to Fig. 5)	Initiatives can be taken for improvement

Katraj is a ward located In the Pune city of Maharastra, India, under the Pune Municipal Corporation (PMC). There is a total of 41 wards. Katraj is the 40<sup>th</sup>, one ward among them which is newly developed and is of mixed-use type of development with residential areas, slums, and commercial land uses. The total population in this ward is 131,000. There are 34,578 households (HHS) in total, from which 675 slum HHS, 31,917 non-slum HHS, and 1,986 commercial properties. This ward is considered the zero garbage ward of the city with no landfill area and proved to be a successful pilot project by PMC. It is being replicated in other wars of the municipality too. This was implemented by the joint effort of PMC and SWach NGO in 2010 (Mastakar *et al.*, 2019). The involvement of the informal waste sector in municipal waste management has also shown considerable improvement in MSW management in Bangalore city.

#### 5. Sectors engaged in Waste management practices

Various stakeholders are involved in the municipal waste management system in India. The critical sectors are the public sector, private sector, and non-

government sectors. The most important role is played by the municipal or local authorities under which the health and sanitation department and the ward-level supervisors are engaged in the waste management process. Other stakeholders are community-based organizations, recycling companies, small and medium enterprises, waste pickers, and most importantly, households (Joseph, 2006).

#### 6. Primary survey

A sample survey is being conducted in the Cuttack development authority neighborhood (CDA) area of Cuttack city of India. CDA is a newly developed planned extension of the old town area. It is planned into different sectors with a residential neighborhood area with the required amenities. The pilot survey is conducted within two residential sectors of CDA (9 and 10) to understand the current situation and ongoing solid waste management practices and also to understand people's acceptance and behavior towards waste management. Random sampling was made to select the respondent in the study area from different socio-economic backgrounds. The following primary survey was done in Cuttack city of Odisha, India where

respondents were asked a few questions related to solid waste management handling issues and improvisation suggestions. Around 50 respondents were selected from different age groups and different economic backgrounds to get feedback on improving municipal waste management practices.

Table 1 is showing the observations taken during the survey.

7. Concluding remarks

Through segregation at the household level and a decentralized waste management system, the local and central bodies can strategically framework to incentivize and monitor the implementation of the system. Citizen participation, correct behavior towards waste, and engagement of all the stakeholders is the key to tackling waste management in India.

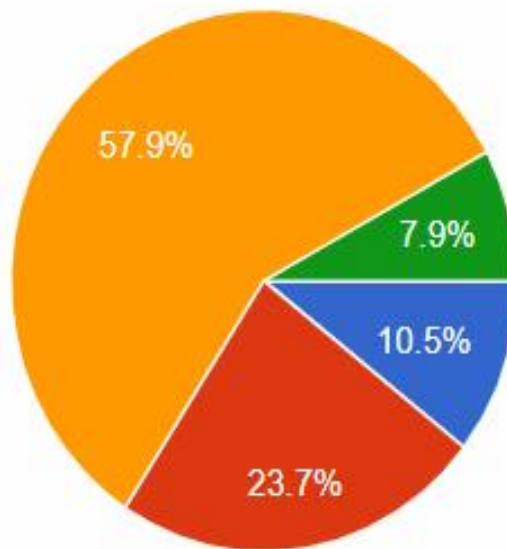


Fig. 2. Opinion of people regarding the impact of waste (Source: Authors).

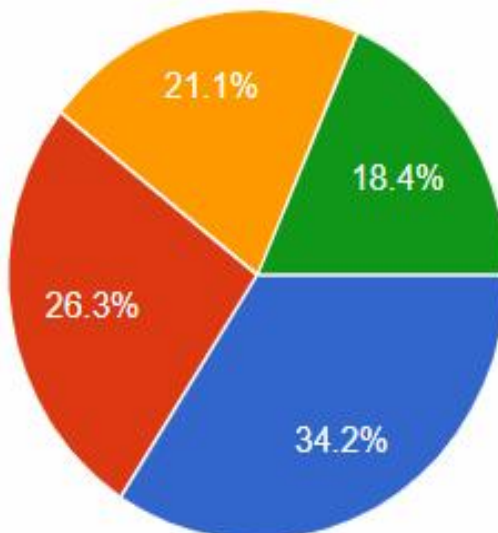


Fig. 3. Composition of household waste in the surveyed houses (Source: Authors).

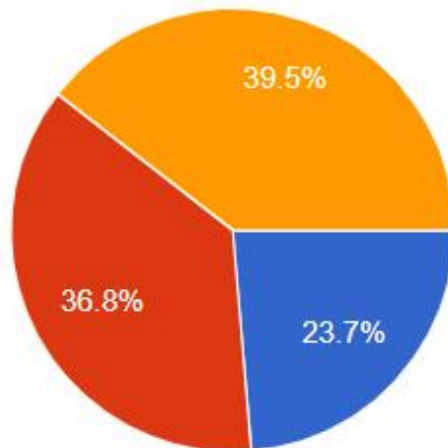


Fig. 4. Segregation status at the household level (Source: Authors).

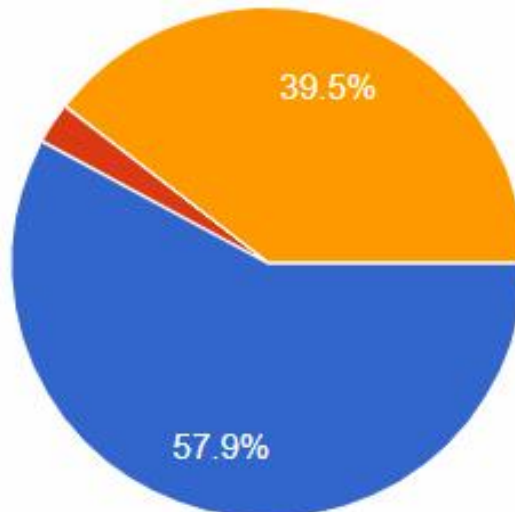


Fig. 5. Willingness to segregate waste if incentives are added (Source: Authors).

Various strategies can also be adopted for plastic waste management which is unavoidable in today's scenario (Huang *et al.*, 2022). Some smart technologies can be implemented to monitor the waste quantity and track the vehicles used for the collection and disposal of waste as done by other countries. Cities in India should practice innovative solutions based on their context while also incorporating common good practices such as effective waste collection methods, enforcement of rules, imposing fines, creating awareness and building capacity of

their human resources, and involvement of the informal sector in SWM management. From the above-mentioned survey done in Cuttack city of Odisha where surveyed people strongly admit that source segregation efficiency can be increased if any benefit such as tax reduction, energy bill reduction, or some rewards such as a coupon for meal or movie tickets can be added in waste management policies. The survey also shows that more than 50% amount of municipal waste is biodegradable type, which can be treated at the ward level to reduce



complicated segregation afterward and reduce covering valuable land as landfill sites.

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