Municipal Waste Management: Issues and Challenges

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Abstract

The increasing industrialization, rapid pace of urbanization and significant changes in the life styles along with the process of economic growth and development are mainly responsible for the generation of waste in the municipal areas in our country. All types of wastes are causing threats to sustainable development. In recent years, technologies are being developed globally in order to reduce the waste considerably as well as generating substantial quantity of decentralized energy. However, municipal waste management is a relatively recent development in India. In our present study, we will address relevant issues and challenges which are being mainly confronted by the municipalities in the urban areas. We will showcase various challenges in the process of municipal waste management and their probable solutions.

Key-words: Municipal waste management, Sustainable development, Municipalities, Issues, Challenges, Solutions.

1. Prelude

The rapid industrialization, urbanization and changes in life style, etc. have given rise to generation of huge quantum of waste leading to increased threats to the environment. In recent years, technologies are being developed and demonstrated globally that not only help in reducing the quantum of waste considerably, but also could generate substantial quantity of decentralized energy.

However, solid waste management is a relatively recent development in Indian context. According to India's Constitution, Solid Waste Management (SWM) falls within the purview of the State Government. The activities are entrusted to Urban Local Bodies (ULB) through state legislations. In most of the Indian cities, the Municipal Solid Waste (MSW) collection, segregation, transportation, processing and disposal is carried out by the respective municipal corporations and the State Governments enforce regulatory policies from time to time.

Management of Municipal Solid Waste (MSW) is one of the most neglected areas of urban development in India. Magnitude and density of urban population in India is increasing at an alarming rate and consequently the civic bodies are facing considerable difficulties in getting

adequate services such as supply of water, electricity, roads, education and public sanitation, including Municipal Solid Waste Management (MSWM).

Municipalities spend about 5-25% of their budget on Municipal Solid Waste Management. In spite of such a heavy expenditure, the present scenario of service in many urban areas is abysmal low and there is frequent threat to public health in particular and to environmental quality in general.

2. Objectives of the Study

The objectives of our present study are as follows:

(i) To highlight the importance of solid waste management in India;
(ii) To give some lights on the present and future scenario of solid waste generation in India;
(iii) To showcase various issues of municipal waste management system prevails in India;
(iv) To address various challenges and their solutions of solid waste management in India.

3. Methodology

The present study is descriptive in nature. For conducting this study, secondary data have been used. We have taken information from various reports published by Planning Commission of India, various published articles, books, periodicals, etc. Based on discussions, specific observations have been made keeping in view the objectives of the study.

4. Discussion & Observation

We have discussed the followings keeping in view the present objectives of our study. We have discussed about the importance of solid waste management in India, present and future scenario of solid waste generation, various issues of municipal waste management system, and various challenges and their solutions of solid waste management in India.

Importance of Solid Waste Management in India

As per estimates, 1,15,000 tons of solid waste are generated per day in the country. Urban Local Bodies (ULBs) spend about Rs. 500 to Rs. 1,500 per ton on solid waste collection, transportation, treatment and disposal. However, hardly any amount is spent on scientific disposal of waste.

It is estimated that solid waste generated in small, medium and large cities and towns in India is about 0.1 kg, 0.3 – 0.4 kg and 0.5 kg per capita per day respectively. Studies carried out by National Environmental Engineering Research Institute (NEERI) indicated that the per capita generation rate increases with the size of the city and varies between 0.3 to 0.6 kg/day in the metropolitan areas have been recorded. The estimated annual increase in per capita waste quantity is about 1.33% per year.

Solid waste management (SWM) is a major problem for many urban local bodies (ULBs) in India, where urbanization, industrialization and economic growth have resulted in increased municipal solid waste (MSW) generation per person (Bhalla, et al, 2013). Effective SWM is a major challenge in cities with high population density.

Despite significant development in social, economic and environmental areas, SWM system in India has remained unchanged. The informal sector has a key role in extracting value from waste, with approximately 90% of residual waste currently dumped rather than properly land filled (Bhoyar, et al, 1999). There is an urgent need to move to more sustainable SWM, and this requires new

management systems and waste management facilities. Current SWM system is inefficient, with waste having a negative impact on public health, the environment and the economy (Biswas, et al, 2010). The waste Management and Handling Rules in India were introduced by the Ministry of Environment and Forests (MoEF) (Das & Bhattarcharya, 2014) although compliance is variable and very limited.

Improvements in civil infrastructure are required for India to become a world leading economy. Developing high-quality infrastructure that meets the needs of the people and protects the environment is fundamental to achieving effective economic growth (Guria & Tiwari, 2010). Waste management infrastructure has an important role in delivering sustainable development. Rapid population growth in India has led to depletion of natural resources. Wastes are potential resources and effective waste management with resource extraction is fundamental to effective SWM. Value extraction from waste can be materials, energy or nutrients, and this can provide a livelihood for many people (Kaushal, et al, 2012). The transition from wastes to resources can only be achieved through investment in SWM as this depends on a coordinated set of actions to develop markets and maximize recovery of reusable/recyclable materials (Kumar, et al, 2014) Materials, energy and nutrient recovery must be the aim of future SWM infrastructure development in India.

From the above discussion, it is very clear to us that solid waste management is prerequisite for sustainable development and need of the hour.

Present and Future Scenario of Solid Waste Generation in India

India is experiencing rapid urbanization and population growth which are the major contributors of waste generation. Megacities are also a relatively recent phenomenon in India. In order to showcase the present scenario of waste generation in India, we have considered seven megacities in our country. Megacities in India include Ahmedabad (6.3 million), Hyderabad (7.7 million), Bangalore (8.4 million), Chennai (8.6 million), Kolkata (14.1 million), Delhi (16.3 million) and Greater Mumbai (18.4 million) (Kumar & Goel, 2009). These have dynamic growth of population and high waste generation per capita, as shown in table 1.

Table 1: Major Cities in India and Per Capita Waste Generation (2010–2011)

City	Population (2011) × 10^6	Total Waste Generated in Tons Per Day	Waste Generation (Kg. Per Capita Per Day)	Rank
Ahmedabad	6.3	2300	0.36	**5**
Hyderabad	7.7	4200	0.54	**1**
Bangalore	8.4	3700	.44	**3**
Chennai	8.6	4500	.52	**2**
Kolkata	14.1	3670	.26	**7**
Delhi	16.3	5800	.41	**4**
Mumbai	18.4	6500	.35	**6**

*Source: *Census of India 2011, #CPCB Report 2011.*

From the above table 1, we observe that waste generation per capital per day is the highest in Hyderabad, followed by Chennai, Bangalore, Delhi, Ahmedabad, Mumbai, and Kolkata. It is also observed that southern India is generating more waste per capital in comparison to other parts of India.

Estimating the quantity and characteristics of MSW in India and forecasting future waste generation is fundamental to successful waste management planning (Kumar, et al, 2009). The quantity of MSW generation depends on living standards, the extent and type of commercial activity, eating habits and season (Mathur, 2012). India generates approximately 1,33,760 tons of MSW per day, of which approximately 91,152 tons is collected and approximately 25, 884 tons is treated (MoEF, 2015). MSW generation per capita in India ranges from approximately 0.17 kg per person per day in small towns to approximately 0.62 kg per person per day in cities, as shown in table 2 (Modak,et al, 2010).

Table 2: Waste Generation Per Capita in Indian Cities

Population	Waste Generation Rate (kg per capita per day)
cities with a population<0.1 million (eight cities)	0.17–0.54
cities with a population of 0.1–0.5 million (11 cities)	0.22–0.59
Cities with a population 1–2 million (16 cities)	0.19–0.53
Cities with a population>2 million (13 cities)	0.22–0.62

Source: Narayan, 2008

World waste production is expected to be approximately 27 billion tons per year by 2050, one-third of which will come from Asia, with major contributions from China and India (Parvathamma, 2014). Waste generation in urban areas of India will be 0.7 kg per person per day in 2025, approximately four to six times higher than in 1999. The problems associated with waste become more acute as the size of communities increase and this provides opportunities for decentralized waste management by self-help groups and NGOs (Rana,et al, 2014).

The waste produced in urban areas of India is approximately 1,70, 000 tons per day, equivalent to about 62 million tons per year, and this is expected to increase by 5% per year owing to increases in population and changing lifestyles (Rana,et al, 2015). Table 3 shows that urban India generated 31.6 million tons of waste in 2001 and is currently generating 47.3 million tons. By 2041, waste generation is predicted to be 161 million tons, a fivefold increase in four decades (Rawat, et al, 2013). This is shown in the following table.

Table 3: Predicted Population Growth and Overall Impact on Waste Generation

Year	Population $\times 10^6$	Total Waste Generation ($X10^3$ Tons Per Year)	Per Capita Generation (Kg Per Day)
2001	197.3	31.63	.439
2011	260.1	47.30	.498
2021	342.8	71.15	.569
2031	451.8	107.01	.649
2036	518.6	131.24	.693
2041	595.4	160.96	.741

Source: (Rawat, et al., 2013)

Various Issues of Municipal Waste Management System

1. *Composition of MSW in Indian Metro Cities*

The local economy impacts on waste composition, as high-income groups use more packaged products, resulting in higher volumes of plastics, paper, glass, metals and textiles. Changes in waste composition can have a significant impact on waste management practices (Sharholy, et al, 2008). MSW may also contain hazardous wastes such as pesticides, paints, used medicine and batteries. Compostable organics include fruits, vegetables and food waste. Healthcare waste contains disposable syringes, sanitary materials and blood containing textiles and is governed by the

Biomedical Waste (Management and Handling) Rules 1998 and the Amended Rules, 2003, and should not be mixed with MSW (Sharholy, et al, 2007). The average composition of MSW produced by Indian cities is approximately 41 wt. percentage organic, approximately 40 wt. percentage inert, with approximately 19 wt. percentage potentially recyclable materials, as shown in table 4 (Sridevi,et al., 2012). Most organic waste is generated from households, and inert waste is generated from construction, demolition and road sweeping. Waste samples collected from Delhi, Ahmadabad and Bangalore indicate that MSW composition varies between cities.

Table 4: Average (% by Weight) Composition of MSW in Indian Metro Cities

Composition of MSW	Compostable	Inert	Paper	Plastic	Glass	Metals	Textile	Leather
Average (% by Weight)	41	40	6	4	2	2	4	1

Source: (Sridevi, et al., 2012)

The MoEF issued MSW (Management and Handling) Rules 2000 to ensure proper waste management in India and new updated draft rules have recently been published. Municipal authorities are responsible for implementing these rules and developing infrastructure for collection, storage, segregation, transportation, processing and disposal of MSW. Chandigarh is the first city to develop SWM in a planned way and has improved waste management compared with other Indian cities (Census of India, 2011).

2. *Waste Collection and Transport*

Waste collection, storage and transport are essential elements of any SWM system and can be major challenges in cities. Waste collection is the responsibility of the municipal corporations in India, and bins are normally provided for biodegradable and inert waste. Mixed biodegradable and inert waste is often dumped, with open burning a common practice. Improvements to waste collection and transport infrastructure in India will create jobs, improve public health and increase tourism (Central pollution Control Board, 2000). Local bodies spend around Rs. 500–1000 per ton on SWM with 70% of this amount spent on collection and 20% spent on transport.

3. Waste Disposal

SWM disposal is at a critical stage of development in India. There is a need to develop facilities to treat and dispose of increasing amounts of MSW (Annepu, 2012). More than 90% of waste in India is believed to be dumped in an unsatisfactory manner. It is estimated that approximately 1400 km^2 was occupied by waste dumps in 1997 and this is expected to increase in the future.

Properly engineered waste disposal protects public health and preserves key environmental resources such as ground water, surface water, soil fertility and air quality. Indian cities with containment landfill sites include Mumbai, Kolkata, Chennai, Nasik, Vadodara, Jamshedpur, Allahabad, Amritsar, Rajkot, Shimla, Thiruvananthapuram and Dehradun .Table 5 shows treatment facilities available in different states in India and table 6 has information on landfills associated with different cities.

Table 5: State-Wise Status of MSW Processing Facilities in India in 2011

State	Composting	Vermicomposting	Biomethanation	Pelletization	Waste to Energy
Andaman and Nicobar	1	Nil	Nil	Nil	Nil
Andhra Pradesh	24	Nil	Nil	11	2

Assam	1	Nil	Nil	Nil	Nil
Chandigarh	Nil	Nil	Nil	1	Nil
Chhattisgarh	6	Nil	Nil	Nil	Nil
Delhi	3	Nil	Nil	Nil	**3**
Goa	14	Nil	Nil	Nil	Nil
Gujarat	3	**93**	Nil	**6**	Nil
Himachal Pradesh	10	Nil	Nil	Nil	Nil
Jammu and Kashmir	1	Nil	Nil	Nil	Nil
Jharkhand	4	Nil	Nil	Nil	Nil
Kerala	21	7	**10**	1	1
Madhya Pradesh	7	Nil	Nil	2	Nil
Maharashtra	6	2	5	5	2
Meghalaya	1	1	Nil	Nil	Nil
Nagaland	1	1	Nil	Nil	Nil
Orissa	1	1	Nil	Nil	Nil
Punjab	1	3	Nil	Nil	Nil
Sikkim	1	Nil	Nil	Nil	Nil
Tamil Nadu	**162**	24	Nil	3	Nil
Tripura	1	Nil	Nil	Nil	Nil
West Bengal	13	7	Nil	Nil	Nil
Total	282	139	15	29	08

Source: Planning Commission, 2014

Table 6: Landfill Sites Associated with Different Cities in India

City	Number of Landfills	Area of Landfills (Hectare)
Chennai	2	465.5
Coimbatore	2	292
Surat	1	200
Greater Mumbai	3	140
Greater Hyderabad	1	121.5
Ahmadabad	1	84
Delhi	3	66.4
Jabalpur	1	60.7
Indore	1	59.5
Madurai	1	48.6
Greater Bangalore	2	40.7
Greater Vishakhapatnam	1	40.5
Ludhiana	1	40.4
Nasik	1	34.4
Jaipur	3	31.4
Srinagar	1	30.4
Kanpur	1	27
Kolkata	1	24.7
Chandigarh	1	18
Ranchi	1	15
Raipur	1	14.6

Meerut	2	14.2
Guwahati	1	13.2
Thiruvananthapuram	1	12.5

Source: Parvathamma,2014

Challenges and their Solutions of Solid Waste Management in India

1. Issues in Household Storage and Segregation of Waste

Most households, shops, and establishments throw their waste just outside their premises, on streets, in drains, in open spaces, in water bodies, and in other inappropriate places. In most cases, source segregation is not done.

Solution

(i) Citizens must be informed and motivated not to litter the streets so they develop the habit of storing their waste at its source in at least two separate bins (one for biodegradable waste and one for recyclable waste).

(ii) Citizens also need to be educated about risks to human health and the environment and taught to separate domestic hazardous waste and infectious waste.

(iii) Municipal authorities must take concerted efforts to convince all classes of citizens to store and segregate their waste properly.

2. No System of Primary Collection

(i) Municipal authorities consider themselves responsible only for waste collection at street collection points and do not feel it is their job to provide doorstep collection service, even though such service is now mandated in the rules.

(ii) Lack of citizen involvement in the storage of waste at source, which would facilitate primary collection from the doorstep.

Solution

(i) An assessment of the housing situation, street conditions, and geographic and topographic situation is always a prerequisite for efficient planning and decision making for primary collection equipment.

(ii) According to the Municipal Solid Waste (Management and handling) rules 2000, there are two options for primary collection: door-to-door collection at preset intervals or community bin collection (known as the bring system).

3. Irregular Street Sweeping

(i) No planning is done to ensure that all streets are swept regularly; there is no benchmark, or yardstick, prescribed by municipal authorities for street sweeping.

(ii) The street sweepers are not given appropriate tools to perform their duties effectively. They are given short-handled brooms, which necessitate constant bending and cause fatigue and loss of productivity.

Solution

(i) A schedule of street cleaning that indicates which roads require daily cleaning and which ones need to be cleaned periodically.

(ii) A program for street cleaning, keeping in view the norms of work (yardsticks) prescribed.

(iii) A timetable for cleaning of open public spaces daily or periodically.

4. Poor Secondary Storage of Waste

(i) Waste depot sites are not evenly distributed in cities and towns.

(ii) They are often very poorly designed and are not synchronized with the primary collection system.
(iii) Waste depots are not emptied on a regular basis.
(iv) Inappropriate secondary storage of waste leads to a "not in my backyard" (NIMBY) syndrome.

Solution

(i) Municipal authorities should identify suitable locations, preferably from among the existing locations of waste storage depots in the city.
(ii) Large containers ranging from three cubic meters to seven cubic meters should be placed for secondary storage of waste.
(iii) Transfer stations should be decentralized within the city, allocated to an enclosed area, and situated in the general direction of the main landfill site.

5. Issues in waste Transportation

(i) Open trucks and tractors used to transport waste are loaded manually. This time-consuming activity results in loss of labour productivity and increases the occupational health risk to workers.
(ii) The transport system is not synchronized with the secondary storage system.
(iii) Problems arise when a transport fleet is not modernized, because waste at the secondary storage system is still dumped on the ground. If the secondary storage system is modernized without an adequate fleet of modern vehicles, similar problems arise.

Solution

(i) The longer the distance to the landfill site, the more volume should be transported with each load. In case of long haul distances to the landfill site, transfer stations are found to be most efficient.
(ii) Vehicles should be selected according to capital costs, carrying capacity, life expectancy, loading speed, local spare part availability, speed, fuel consumption, and maintenance costs.
(iii) The transport of waste can be managed and monitored centrally or through a large decentralized arrangement. Transport can be contracted out to private operators.
(iv) The transport system must be harmonized with the secondary storage system of waste to prevent manual and multiple handling of waste.

6. Lack of Waste Treatment

(i) The MSW generated in Indian cities is, by and large, not treated but is directly taken to the open dumpsites.
(ii) Although India is known for its age-old technology of composting agricultural waste, composting of municipal organic waste is infrequent. In a few cities, however, initiatives exist for aerobically composting or vermicomposting of municipal organic waste.
(iii) However, many plants are not operated according to their installed capacity. Many plants face problems with compost marketing and find financial sustainability difficult.

Solution

(i) The municipal authorities must treat the organic fraction of waste before disposal.
(ii) The authorities are expected to set up a plan for composting waste or to adopt waste to-energy technology as may be appropriate.
(iii) Municipal authorities have to assess the suitability of new technology to Indian conditions.

7. Inappropriate Disposal of Waste on Open Dumping Grounds

(i) Waste is dumped in low-lying areas that are within or outside the cities and that are designated as dumping grounds or in unauthorized areas on the outskirts of the city.

(ii) Sometimes waste is even dumped on the approach roads to rural areas, which do not have their own land for disposal of waste. Such practices result in extremely unsanitary conditions and create serious environmental degradation problems.

(iii) Because no segregation of waste at its source takes place, domestic waste of all types, infectious waste from medical facilities, and even hazardous industrial waste are deposited at dumpsites that are actually designated for domestic waste.

Solution

(i) The state pollution control boards are required to prescribe the criteria for site selection in terms of distance to be maintained from habitation, water bodies, highways, railways, and so forth.

(ii) The municipal authorities should follow the rules carefully when constructing an engineered landfill.

5. Conclusion

Rapid growth of population and particularly the emergence of megacities is making SWM in India a major problem. The present situation is that India relies on inadequate waste infrastructure, the informal sector and waste dumping. There are major issues associated with public participation in waste management system and there is a lack of responsibility towards waste management in the community. There is a need to enhance community awareness and change the negative attitude of people towards waste, as this is fundamental to developing proper and sustainable waste management systems. Sustainable and economically viable waste management must ensure maximum resource extraction from waste, combined with safe disposal of residual waste through the development of engineered landfill and waste-to-energy facilities. Until these fundamental requirements are met, India will continue to suffer from poor waste management and the associated impacts on public health and the environment.

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