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Study on municipal solid waste management and challenges faced in Indian metropolitan cities

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Abstract

Waste management and disposal is the most severe environmental issue all over the World. In developing country like India, there is prompt increase in municipal solid waste due to urbanization and population growth. Composition of waste varies with different factors like living standard, climatic conditions, socio-economic factors etc. Waste management incorporates entire process from collection and treatment to disposal by incineration, landfill and other methods, and recycling. The objectives of inscription of this paper is to study the existing practices related to the various solid waste management initiatives taken and challenges faced in managing municipal solid waste. The other purpose is to provide some recommendations to improve the waste management practices in India

Keywords: Municipal solid waste management, problems and challenges in MSWM, MSWM in metropolitan cities

1. Introduction

Solid waste is a material that is not useful and does not represent any economic value to its owner (Kadam and Sarawade, 2016) ^[18]. Solid waste management (SWM) is an acute problem for developing countries like India. Escalating incomes, rapidly growing but unintended urbanization, and altering lifestyles leads to increased volumes and varying composition (increasing use of paper, plastic and other inorganic materials) of municipal solid waste in India. Waste is generated from all human activities.

The Municipal Solid Wastes (Management & Handling) Rules, 2000 (MSW Rules) ^[14] implies on every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid waste. These rules contain four schedules namely implementation schedule, management of municipal solid wastes, specifications for landfill sites and standards for composting treating leachates and composting, etc. (MOEF, 2000).

Municipal Solid Waste has been a major issue in developing countries like India. There is rapid increase in population, developmental activities, improvement in the standard of living etc. and thus a simultaneous increase in the generation of wastes which eventually becomes a major environmental, socio-economic and health concern (Gupta *et al*, 2015) ^[6].

The urban MSW in India constitutes of 51% organics, 17.5% recyclables (paper, plastic, metal, and glass) and 31% of inert. The moisture content of urban MSW was found to be 47% and the average calorific value was 7.3MJ/kg (1745kcal/kg) (Parvathamma, 2014) ^[17]. In a report by Planning Commission (2014) ^[19] it was revealed that at present 62 million tons of MSW is generated annually by 377 million people residing in the urban areas. This is projected to be increased to 165 million tons by 2031 and further increased to 436 million tons by 2050.

Patnaik and Reddy, 2010 ^[18] stated that generation and management of solid waste may vary from country to country, state to state, city to city as well as within different areas of the same city. They further notified that In Indian cities the solid waste generation varies in the range 0.3 and 0.6kg/capita/day and municipal solid waste generation increase in volume is estimated to be 1.33% per capita annually. In India the most common method used for the management of municipal solid waste is that is disposed of in low lying areas or open dumps without any necessary precautions. It is the reason that municipal solid waste management is one of the most challenging environmental issues here (Siddiqui, 2018) ^[20].

In the present study, an attempt has been made to provide a comprehensive overview of the

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current status of the MSW in the metropolitan cities in India, the health and environmental impact of the MSW, the problems and challenges being faced and the recommendations that could be made to improvise the situation.

2. Current status of MSW management in India's metropolitan cities

In the developing countries like India the rate of municipal solid waste generation has increased due to rapid migration of

people from rural to urban areas (Minghua *et al.* 2009) [13]. In India 31.16% of the population lives in the urban areas (Census of India 2011; Sudhir and Gururaja 2012) [21]. The cities in the world generated 2.01 billion tons of solid waste in 2016. This led to the footprint of 0.74kilogram per person per day. And with the present trend going, there is an expected increase in generation of annual waste by 70% from 2016 levels to 3.40 billion tons in 2050 (World Bank, 2018). In India 31.16% of the population lives in the urban areas.

Table 1: The data depicts the generation of Municipal solid waste in the major metropolitan cities in India since 1999 to 2016.

S. No.	City	Population (2011)	Waste Generation (TPD)			
			1999-2000	2004- 2005	2010- 2011	2015- 2016
1.	Mumbai (MH)	12,442,373	5355	5320	6500	11,000
2.	Delhi I	11,034,555	400	5922	6800	8700
3.	Bangalore (KRN)	8,443,675	200	1669	3700	3700
4.	Chennai (TN)	7,088,000	3124	3036	4500	5000
5.	Hyderabad (Tel)	6,731,790	1566	2187	4200	4000
6.	Kolkata (WB)	4,496,694	3692	2653	3670	4000
7.	Surat (GUJ)	4,467,797	900	1000	1200	1680
8.	Pune (MAH)	3,124,458	700	1175	1300	1600
9.	Kanpur (UP)	2,765,348	1200	1100	1600	1500
10.	Visakhapatnam (AP)	2,035,922	300	584	334	350

In the above table the data depicts the generation of Municipal solid waste in the major metropolitan cities in India since 1999 to 2016. There is seen an increase in the waste generation in all the cities but in some cities the increase is excessive increase like in Delhi where the increase in the waste generated tons per day (TPD) is highest i.e. difference of 8600 TPD from 1999 to 2016, followed by Mumbai where the difference is 5645 TPD from 1999 to 2016 and Bangalore where the difference was found to be 3500 TPD. The major reason for such excess increase in the generation of waste in these cities could be their popularity for migration for the reasons like employment, rapid development, better infrastructure, higher education, etc. out of all the above cities as per the census 2011 data Mumbai is most populated followed by Delhi then Bangalore and Chennai. As per World Bank, 2018 1/3rd of solid waste is openly dumped or burned. The MSW is divided into five main types i.e. metal (4%), glass (5%), Plastic (12%), paper/cardboard (17%), food/green (44%). It further adds that over 90% of waste is poorly managed in low-income countries. This leads to increase in the risk of emissions and disasters, further affecting the poor disproportionately.

3. Present Management Practices

The management practices followed in India for municipal solid waste management is represented by the figure (Fig 1) given below.

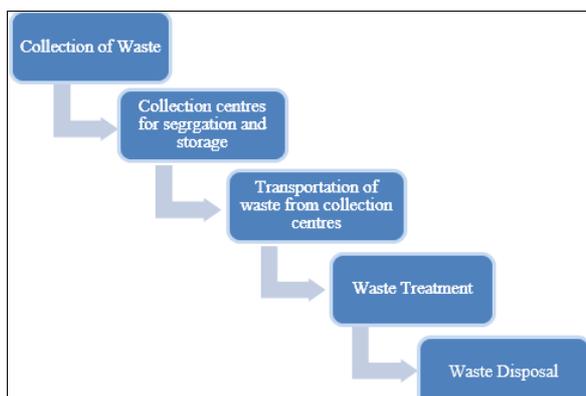


Fig 1: Current Practices followed for management of Municipal Solid Waste

Collection of Waste: Waste is generated from both residential and commercial activities. Method of waste Collection is different in cities and even in areas of a city. Door to door collection is not generally practiced. Some residential societies rent private staff for door-to-door collection of solid waste. The urban local authorities do not have suitable arrangement for collection of waste from narrow streets and high traffic areas. The slums and squatters in cities also generate unhygienic conditions. Disposal of sewage, waste and open defecation from such areas need appropriate attention. Cattle rearing in residential areas also generate lot of problems. Cow-dung and other waste is not handled appropriately. Vegetables, fruits and eatable sellers also throw their wastes carelessly, which need attention for proper management.

Collection Centers: According to CPCB survey findings some of the cities do not have proper norms or guidelines for setting up of waste collection centers. Each city has its own method of setting collection centers and which are primitive methods. In some cities, mechanized bins are used for both collection and transportation of waste at primary level, Secondary collection facility is used in which waste is collected in smaller bins from communities and then transferred into larger bins Proper attention is also needed for upkeep of such waste collection centers

Transportation of Waste: Transportation of waste from collection centers to final disposal or treatment site is also an important step in waste management process It has been projected that 60% waste is collected for transportation but proper transportation is not done because of major problems in transportation such as non-availability of sufficient transportation taskforce; frequent breakdown of vehicles; and absenteeism of staff etc. The vehicles carrying waste to disposal sites should be covered as its exposure is causing public nuisance. Vehicles used for transportation are trucks, tractors, animal drawn carts etc. Waste for transportation is loaded manually which causes nuisance to workers due to exposure to the open. Daily transportation of waste should be done throughout the year. In the areas where large sized waste collection centers are difficult to place, waste collection

vehicle of appropriate size may be introduced. Such system has been practiced in Ahmedabad.

Waste Treatment: Waste treatment is happening on very low scale in comparison to generation of waste. The waste which is recyclable sent to the recycle units, the waste which is organic sent to compost plants and the remaining waste is sent to waste to energy plants. The waste sent to waste to energy plants is very less and of bad quality which has very low calorific value due to lack of proper segregation, collection and transportation system.

Waste Disposal: Waste disposal should be done by using scientific methods (Sanitary landfills) in a well-managed land. Landfilling is a slow and time consuming process. Thus careful actions are required throughout. Identification of a suitable site is most important aspect in selecting landfill site. In India, most of the landfill sites are abandoned dumps and are not sanitary landfills where all type of wastes (domestic, commercial; industrial and hospital) is dumped together. Sites identified for filling are not correctly maintained. According to information collected by CPCB through EPTRI, the average disposal by landfill is about 91%.

4. Hierarchy of Sustainable Waste Management

There is no any entrenched structure for collection and handling of solid waste which has become a severe problem for environment and effects on the people's life style. Earth Engineering Center at Columbia University developed hierarchy of Sustainable Waste Management which is broadly used as a reference to sustainable solid waste management and disposal.

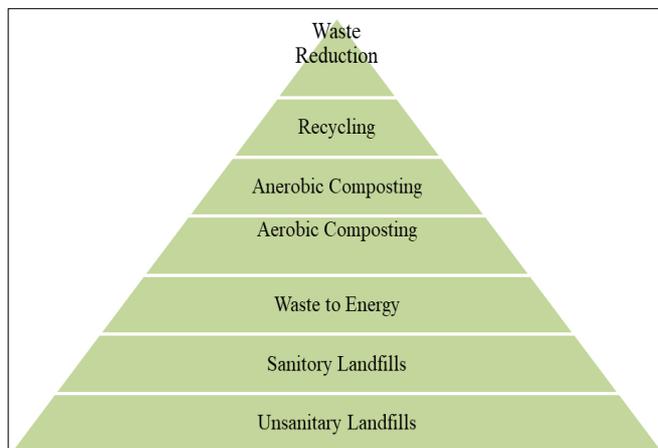


Fig 2: Hierarchy of sustainable waste management (Kadam and Sarawade, 2016) ^[8]

The pyramid shows (Fig.2) that the waste reduction and reuse of the waste materials are the superior options for decreasing the generation of waste, but it cannot come to level zero. Once the waste is produced it need to be collected, recycled, composting and remaining for waste to energy for effective waste management. The last option is open scorching and unsanitary landfills.

5. Challenges faced in managing municipal solid waste in India

In India, Municipal Solid Waste Management is a major problem and Urban Local Bodies do not have suitable action plans for implementation unfortunately, no city in India can claim 100% segregation of waste at dwelling unit and on an

average only 70% waste collection is observed, while the remaining 30% is again mixed up and lost in the urban environment. Out of total waste collected, only 12.45% waste is scientifically processed and rest is disposed in open dumps (CPCB Report, 2013). Following are the challenges faced in managing Municipal Solid waste in metropolitan cities.

- 1. Lack of awareness of people:** The awareness plays significant role in Municipal Solid Waste Management and enhances the efficiency of waste management system. It is the utmost critical phase in the whole process of Municipal Solid Waste Management, which helps in managing solid waste leading to eventual achievement. Awareness and civilian involvement to segregate waste at source, door-to-door collection, and disposal in proper collecting bin is imperative. However, the present scenario of India reveals that there is practically no segregation of waste at cradle which leads to various environmental problems and it turns into very difficult to separate waste at handling site. (Kadam and Sarawade, 2016) ^[8]
- 2. Source Segregation and Collection:** In India there is practically no systematically planned source segregation excluding industrial waste where due to organized nature of sector, segregation is sometimes practiced and for healthcare waste due to regulatory requirements. Segregation is mostly done by unorganized sector (scavengers and rag pickers) and hardly done by waste generators. Hence, the proficiency of segregation is pretty low as the unorganized sector tends to segregate only those waste ingredients which have comparatively higher monetary return in the recycling market. The conditions under which segregation and sorting is done are unsafe and hazardous. Substantial quantity of waste is left to decay on the roads and/or is discarded into low lying areas, channels, rivers etc. Factors responsible for such low collection efficiency are lack of appropriate collection systems, insufficient collection facilities such as waste dumping bins, collection vans etc., lack of funds, lack of and enforcement of suitable guidelines etc. (Kaushal, Varghese and Chabukdhara, 2012)
- 3. Transportation of waste to the collection centers-** Transportation of waste from the source to the collection center is the responsibility of scavengers deployed for the purpose and door to door collection is required to be done but in actual situation this work is either done by people themselves or by privately employed workers, scavengers. Generally the vehicles used for the purpose are bin hand carts, simple hand carts, tricycles, which leads to mixing of organic or inorganic waste. (Joshi and Ahmed, 2016) ^[7]
- 4. Urbanization and lack of finance:** With the population growth, challenge to provide adequate infrastructure in urban area and new landfill site selection is important. Most of the landfill sites are running beyond their capacity in metropolitan cities. Inadequate financial support to cater to waste management problem aggravates it. Due to financial crunch Urban Local Bodies do not have adequate infrastructure to provide suitable solutions. (Joshi and Ahmed, 2016) ^[7]
- 5. Implementation of rules at ground level:** Urban Local Bodies are not executing Municipal Solid Waste Rules effectively as discovered by various government reports; thus it is difficult to manage the Municipal Solid Waste suitably. There is a need to form enthusiastic group of officers and skilled staff for Urban Local Bodies with

specialization in Municipal Solid Waste Management. Sufficient training and hands-on experiments would allow them to recognize problems at execution level and take applicable action. (Kaushal, Varghese and Chabukdhara, 2012)

6. **Financing issues:** To support waste management one of the most persistent issues is the availability of capitals. The local authorities are typically in a terrible financial situation and are hardly able to maintain the elementary jobs of waste collection and disposal. Municipal level waste management continues to be heavily subsidised by governments. Financing mechanisms to promote use of environmentally Sound Technologies, for technology development and demonstration are conspicuous by absence.
7. **Lack of coordination among center and state:** There is less discussion between Central and State government. Suspension in submission of information from State to Central delays suitable implementation at ground level. Such lack of coordination for specific action plan and poor strategy at implementation level by ULBs are main hindrance. (Joshi and Ahmed, 2016) ^[7]
8. **Lack of suitable solutions:** Environmentally suitable practices are the need of the hour to handle the growth of Municipal Solid Waste. Suitable technological solutions through Public Private Partnership are required. For managing Municipal Solid Waste there is need for Public Private Partnership to implement management with the latest technology Formation of the noble public governance in compliance with secured regulatory framework and suitable financial support and strict agreement implementation is required for the success of Public Private Partnership. Capacity building and availability of trained labor, familiarity with new and as well as best practices available for waste management, financial encouragements for identifying new technologically feasible solutions, suitable and fast decisions at Urban Local Bodies level for efficient implementation are real problems. (Joshi and Ahmed, 2016) ^[7]
9. **Failure of waste-to-energy projects:** India is still stressed to make waste-to-energy project a successful technique to manage Municipal solid waste. There is a need to import financially viable and verified technologies. Waste to energy plants need to get segregated and waste of high calorific value for proper working and make it a successful story. (Joshi and Ahmed, 2016) ^[7]
10. **Involvement of unorganized sector:** For progressing Municipal Solid Waste collection and source segregations, rag-pickers can be placed through organized sector. However, due to lack of recycling facilities and recognition of society this massive potential has been unnoticed. (Joshi and Ahmed, 2016) ^[7]

6. Environmental and health impacts of municipal solid waste

Municipal solid wastes impact the environment and the public health adversely. Anaerobic decomposition of the biodegradable wastes causes release of Methane which might cause fires, explosions etc. and also it's a major contributor to global warming (Kumar *et al*, 2017) ^[12]. Rapid urbanization aggravates the problem of improper disposal of waste and very few of the existing landfill sites in the developing or poor nations would meet the standards set by the

industrialized countries. This would cause enhanced greenhouse effect and lead to climate change on a larger scale. Secondly, the liquid leachate which contaminate the ground surface and the water system in ground. Thus, to prevent this in-soil infiltration the use of sanitary landfill sites is a must. The optimum strategy to contain excess liquid is the use of dense clay deposits at the bottom of waste pits, coupled with plastic sheeting-type liners. For example in Tamil Nadu, India where the constituents like total dissolved solids (TDS), total hardness (TH), Total alkalinity (TA), Sodium (Na⁺), Magnesium (Mg⁺), Chloride (Cl⁻), Fluoride (F⁻) and Nitrate (NO₃⁻) were observed to be above than the permissible limit for drinking and making the water not portable (Nagarajan *et al*. 2012) ^[15]. The gases like methane and carbon di oxide are released mainly from the landfills along with some amount of volatile organic compounds and other trace gases. And both these gases have a potential of leading to global warming due to their greenhouse gas effect. Methane has 25 times higher potential of greenhouse gas effect than CO₂ with atmospheric residence time of 12 ± 3 years (Siddiqui, 2018) ^[20]. Unsanitary disposal of wastes not only has an environmental impact whereas it also takes a toll on the health of the people and even some animals. India is a country where in summers the temperature would exceed even 45°C, which leads to serious problems of odor from the dumping sites or waste heaps. Other waste materials like tyres or containers collect water and causes breeding of mosquitoes increasing the occurrence of malaria, dengue, etc. Other ways of disposal of wastes adopted like uncontrolled burning would aggravate respiratory diseases and smog due to release of fine particles. Hence, the poor management of wastes might lead to various health issues to the people like increased incidences of nose and throat infections, breathing difficulties, inflammation, bacterial infections, anemia, reduced immunity, allergies, asthma and other infections (Kumar *et al*, 2017) ^[12].

7. Recommendations and Solutions

1. Awareness among people about the significance of source segregation at generation sites as biodegradables, inert and recyclable material and change in habits to store, segregate and dispose of waste according to direction of municipal council for effective waste management
2. After segregation of waste, methods like composting/Vermicomposting should be used for organic/biodegradable waste. (Kumar and Pandit, 2013) ^[10]
3. Decentralized composting plants should be made to reduce the burden on Urban Local Bodies for collection and transportation of Municipal Solid Waste, which successively results in drop in the pressure exerted on the landfills. Segregation plan at city level should be made to dispose of recyclable and hazardous waste suitably.
4. Classification of waste at collection and disposal site should be made. Government should take initiative to inspire Institutions and Universities to include waste management in their curriculum.(Joshi and Ahmed, 2016) ^[7]
5. In order to reduce waste at dumping site, Incinerators, composting methods can be used.
6. Dumping sites or landfills should be far from residential area or occupancy .and preferably it should be barren land. (Kumar and Pandit, 2013) ^[10]
7. Production and use of non-recyclable polyethylene bags should be banned and biodegradable polyethylene should

be made available for usage.

8. Rag-pickers and sweepers are considered as substandard class of citizens despite numerous laws in place to bring dignity to their occupation. Awareness for changing people's views and perspective regarding this significant service to community should be initiated.
9. Groundwater contamination from leachate percolation from open landfill site should be protected compulsorily by using suitable technologies. (Joshi and Ahmed, 2016) [7]
10. Public Private Partnership is required for effective and efficient treatment and disposal of municipal solid waste (Kumar and Pandit, 2013) [10]

8. Conclusion

Solid waste management has been a major issue since decades in the cities and the situation continue to aggravate with time due to continuous development and increase in population. In order to make the cities livable sustainable management of waste is needed. There should be community mobilization to sensitize them towards their contribution in waste management, increase in the better infrastructure for the MSW management, sanitary and monitored landfill sites and also waste to energy technologies to be promoted.

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