International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

A Technical Report on Solid Waste Management of Mumbai

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Abstract: ***In the present scenario where the amount of wastes are increasing day by day, the use of proper solid waste management system turns out to play a vital role. Solid waste management plays an important role in the overall functioning of the society or as a whole the environment. If solid waste management is not carried out systematically, the effects will be adverse for the people as well as for the environment. In large cities like Mumbai, the management of wastes alone by the municipal corporations cannot meet the need of the proper solid waste management system. Hence, the municipality has turned out to work on a decentralized manner with the help of NGOs and various organisations. Though decentralized system run on smaller scales, but with the effective participation of people as stakeholders gave rise to the waste traders or "raddiwallahs" who are seen at various spots of the cities, who sell the recyclable wastes to make their fruitful use. Due to all these approaches, decentralized system is leading to a greater success in recent times. Advanced locality model is a type of optimisation model for SWM system. As per the model, three plants were installed, of which, 1st plant is community compost plant, 2nd is mechanical 5aerobic compost plant, 3rd plant follows sanitary landfilling techniques. These plants ultimately turn wastes into useful products like manure, converting landfill gas into CNG etc. The amount of waste generation cannot be reduced but with proper recovery of the wastes, the problem of solid waste management can be resolved. The principle of 4R: Reduce, Reuse, Recycle and Recover should be adopted. Various methods like biomethanation, gasification, incineration, vermicomposting, aerobic composting etc. should be introduced for the proper maintenance of SWM.***

Keywords: Solid waste management; Stakeholders; decentralization; Advanced Locality model

1. Introduction

Wastes are the day to day garbages, rubbish or human excreta which are to be disposed off from the source. Waste generation in a city is directly proportional to its population. The management of the wastes by proper collection, disposal to the sites and recycling it for future reuse is called Solid Waste Management (SWM). Solid waste management plays an important role in the overall functioning of the society or as a whole the environment. If solid waste management is not carried out systematically, the effects will be adverse for the people as well as for the environment.

In major cities, the SWM has been decentralized in order to employ vast network of stakeholders/people for the better management and collection of wastes. The manpower involved and the transportation facilities play a major role in the management of solid wastes.

The SWM of Mumbai is a major challenge for the Municipal Corporation as Mumbai has a vast population range. Waste generation depends on the population and the socio-economic status of the people, and in Mumbai city, since the socio-economic status of most of the people staying is quite advanced, so the waste generation in Mumbai is also very high. As per data of 2018, Mumbai accounts to be the 2nd populous city of India after the national capital, Delhi. Being the capital city of Maharashtra, Mumbai is spread with a total area of 603.4 sq. km. Geographically, Mumbai has been divided into three sections, namely the island city (the main city), the western suburbs and the eastern suburbs.

Figure 1: Map of Mumbai
(Source: google images)

According to the latest census data, Mumbai's total population has been recorded as 13 million which is further increasing on a daily basis. The total wastes generated as per Brihanamumbai Municipal Corporation (BMC) is 7500 tonnes per day or 27.37 lakh tonnes during a year, which stands to be the third within the state of Maharashtra[1].

The Municipal Corporation of Greater Mumbai (MCGM) or Brihanamumbai Municipal Corporation (BMC) is formally responsible for the management of waste in Mumbai city. In Navi Mumbai, Navi Mumbai Municipal Corporation (NMMC) collects the wastes and dispose off to the dumping grounds. Out of the 8 Municipal Corporations of Mumbai Metropolitan Region (MMR), which consists of the Mumbai

city as well as some towns of Maharashtra, the BMC or MCGM is the governing body of Mumbai.

2. Data of Wastes Generated in the City

As a whole, Maharashtra generates 21867.27 tonnes per day (TPD) of Municipal Solid Wastes (MSW), of which 6993.2 TPD are treated and 14993.07 TPD are landfilled [4]. As per recent data available, Mumbai alone produces 7700 MT/day of solid waste which is collected by Municipal Corporation of Greater Mumbai (MCGM). Out of this, 4407 MT/day of solid waste is treated, 190 MT/day is transported for dumping. General waste composition and MSW composition of recyclables are depicted in Figure 2 and 3 respectively.

Waste generated: 7700 MT/day
Waste treated: 4407 MT/day

Table 1: Quantity of various types of wastes

Type of waste	Quantity Generated per day (MT/day)
Biodegradable/recyclable	5700
Debris/silt	2000

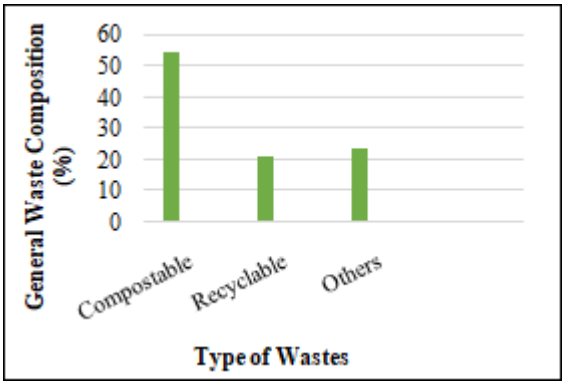

Figure 2: General Waste Composition of Mumbai

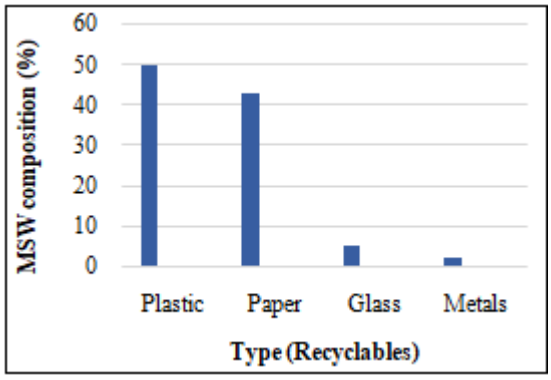

Figure 3: Mumbai's MSW composition of recyclables

3. Role of Various Bodies

3.1 Role of MCGM OR BMC

Municipal Corporation of Greater Mumbai (MCGM) or Brihanamumbai Municipal Corporation (BMC) is responsible formally for collecting of wastes from the city of Mumbai. It has installed around 5800 community bins in the city. There are basically five dumping grounds in the city, of which three are already closed or have met its active period. The dumping grounds are Deonar, Gorai (Borivali), Mulund, Chincholi and Malad[6]. Deonar and Malad are the active dumping grounds which are being used for disposal of wastes. Deonar is the largest dumping ground. The MCGM uses both municipal and private contract vehicles for collection and transportation of wastes. Wastes are collected from the community bins and are transported to the dumping sites.

For South Mumbai area, the wastes are collected from community bins and are transported to a transfer station, which is at Mahalakshmi. A separate transport is arranged for transferring the wastes from Mahalakshmi to Northern part of Mumbai where dumping grounds are located. For all other regions, the wastes are directly transported to the dumping grounds.

The vehicles used for transportation of waste generated in Mumbai make 1600 trips each day. The number of municipal and private vehicles is 312 and 617 respectively [8].

The processing facilities available for MSW are bioreactor landfill, composting, Refused derived fuel (RDF) and Leachate treatment [10].

The overall budget allocated for MCGM or BMC is 33000 crore rupees, which is for both infrastructure development of the city as well as for Solid Waste Management.

3.2 Role of Stakeholders

All the Municipal Corporations of the Mumbai Metropolitan Region (spanningabout 4355 sq. km) depend upon centralized means of managing wastes at present. But due to the efforts from the communities, institutions and NGOs, steps have been taken to make the system decentralized in order to achieve greater efficiency of the waste management system. The city of Mumbai interacts with various stakeholders to manage the waste effectively[3]. Though decentralized system run on smaller scales, but with the effective participation of people as stakeholders gave rise to the waste traders or “raddiwallahs” who are seen at various spots of the cities, who sell the recyclable wastes to make their fruitful use. Due to all these approaches, decentralized system is leading to a greater success in recent times.

Figure 4: Stakeholder map (Source: google images)

Introduction to Optimization Models For SWM in Mumbai (Advanced Locality Model):

The BMC or MCGM alone cannot effectively manage solid wastes in Mumbai city due to the increasing population which ultimately increases the daily production of wastes. So, the communities have taken measures to resolve the problem. In a study of various ways of managing wastes, Rathi[5]proposed an Optimization Linear Model for integrated municipal solid waste management, called as Advanced Locality Model (ALM), as shown in Figure 5.

Started in 1997, it aims to resolve the problems of MCGM which occurred due to growing industrialization, urbanization, increasing population, etc. ALM brings together the communities, ward people, NGOs etc. who work together as a single unit. As per the model, three plants were installed, of which, 1st plant is community compost plant, 2nd is mechanical aerobic compost plant, 3rd plant follows sanitary landfilling techniques. These plants ultimately turn wastes into useful products like manure, converting landfill gas into CNG etc.

Many studies were carried out to know the benefits and efficiency of ALM. Many alternative approaches for SWM have been suggested by researchers, among which ALM is found to be more cost effective as well as having high efficiency of work. The cost per tonne of waste management by community participation or the ALM has turned to be ₹1518, which is lesser than ₹1908 by MCGM[5].

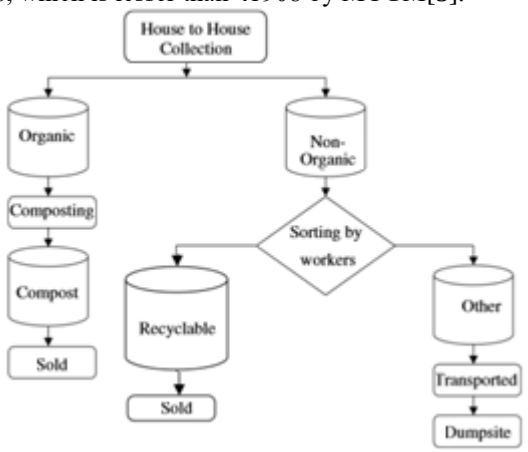

Figure 5: ALM (Community participation in waste management)(Source: google images)

Effect of Improper SWM

The improper Solid Waste Management (SWM) leads to adverse condition of the environment. The wastes are dumped or disposed off in open areas or illegal dumping spots which create nuisance among the surrounding people as well as pose a threat to the environment.

In various studies done by Siva Raju[7], Bhupen K Sharma[8], Rameez et al.[10], the effects of hazardous wastes lying on the street sides were emphasized and brought into notice by highlightng the mortality rates due to such man-made hazards. In a study[2], the AirQ+ software, developed by World Health Organisation (WHO) was used to quantify the health risks in terms of excess number of cases (ENCs) of mortality caused due to various health impacts from the improper disposal of wastes.

Due to the increasing quantity of wastes, which is because of the increasing population, the number of trips made by vehicles to transport wastes are also shooting up which is unfortunately affecting the environment raising the level of air pollution. The emissions from the vehicles are harmful in the long run[8]. The major emissions produced by the vehicles is CO_2. The pollutants (CO_2, CO, HC, NO_x and PM) from the vehicles contribute to the increase of greenhouse gases in the atmosphere.

Table 2: Emission load of Mumbai City in the year 2010–2011 (tons/day)[7]

S. No.	Use	SO_2	Particulate Matter	NO_x	CO	Hydro-carbons	Total
1	Domestic	4.41	9.15	29.23	93.89	34.74	171.34
2	Industrial	24.01	0.21	0.05	-	-	24.27
3	Refuse burning	0.16	1.56	0.32	5.99	2.22	10.25
4	Transport (diesel)	5.96	2.48	34.15	18.12	7.16	67.87
5	Transport (petrol)	0.66	0.18	18.2	265.3	39.05	323.39
	Total	35.2	13.58	81.95	383.22	83.17	597.12

The total global warming potential (GWP) from the transportation of MSW is obtained as 0.07 million tonnes CO_2equivalent per year, which is 2.8% of total GWP and which resulted from the present MSW management system of Mumbai. These are causing unfavourable climate changes in the city[7]. Mumbai experiences a warm and humid climate for half of the year. The annual rainfall ranges between 180 to 248 cm. Due to global warming, in most of the months, Mumbai experiences temperature as high as 40 to 50˚C.

Further, the dumping of wastes in illegal dumping spots or in open areas lead to emissions of toxic gases or volatile organic compounds (VoCs) in the environment causing serious health impacts on the people.

4. Scope of Development of SWM

Although with the help of ALM and MCGM, the solid waste management system of Mumbai has become stable but with increasing waste generation, new systems and techniques are to be implemented. The amount of waste generation cannot be reduced but with proper recovery of the wastes, the problem of solid waste management can be resolved.

The principle of 4R: Reduce, Reuse, Recycle and Recover [Figure 6] should be adopted [9]. Various methods like biomethanation, gasification, incineration, vermi-composting, aerobic composting etc. should be introduced for the proper maintenance of SWM.

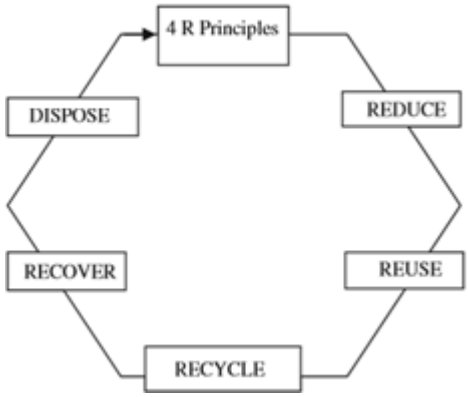

Figure 6: Hierarchy of 4R principles (Source: google images)

5. Conclusion

Along with the efforts of Municipal Corporation, contribution of each and every citizen is required for clean and eco-friendly environment. The people should avoid throwing wastes on the roadsides. The people with this type of careless behavior should be punished by the government with a view to avoid such occurrences in the future. The wastes should be properly disposed off in the community bins or some arrangements of recycling or reusing them should be adopted. The wastes which cannot be recycled/reused should only be discarded.

Due to the participation of some active citizens of Mumbai, the various issues of SWM have been solved. Observer Research Foundation, Mumbai, has done a case study on different measures adopted by the citizens of Mumbai[3]. In Malad, an active citizen has took charge of ensuring regular pick-up of wastes in his society, which killed the dumping spots in his locality.

In Vile Parle, a college has been managing its biodegradable wastes for the last seven years by setting up vermicomposting bin in a 6 m X 3 m pit.

Such small initiatives from the people of Mumbai, in the long run will turn Mumbai's SWM system to its best.

Mumbai, being a home to rich people residing in high-rise apartments, as well as poor people residing in slum areas, has been overpowering all the worst impacts of the SWM system till date due to such small initiatives. Thus, in a fight to save the environment and the people, each and every act of responsibility will undergo a change and make earth a better place to live.

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