"A Critical Study on Proposal for Municipal Solid Waste Management for the Indian Green City"

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Abstract – Municipal solid waste management (MSWM) is one of the major environmental problems of Indian Green cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. Various studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. In the present study, an attempt has been made to provide a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in India. The study pertaining to MSWM for Indian Green cities has been carried out to evaluate the current status and identify the major problems. Various adopted treatment technologies for MSW are critically reviewed, along with their advantages and limitations. The study is concluded with a few fruitful suggestions, which may be beneficial to encourage the competent authorities/ researchers to work towards further improvement of the present system.

Keywords: Municipal, Solid, Waste, Management, Indian, Green City, MSWM, Problems, Public Health, Environment, Technologies, Limitations, Beneficial, Improvement.

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INTRODUCTION

Rapid industrialization and population explosion in India has led to the migration of people from villages to cities, which generate thousands of tons of MSW daily. The MSW amount is expected to increase significantly in the near future as the country strives to attain an industrialized nation status by the year 2020 (Sharma and Shah, 2005; CPCB, 2004; Shekdar et al., 1992). Poor collection and inadequate transportation are responsible for the accumulation of MSW at every nook and corner. The management of MSW is going through a critical phase, due to the unavailability of suitable facilities to treat and dispose of the larger amount of MSW generated daily in metropolitan Green cities. Unscientific disposal causes an adverse impact on all components of the environment and human health (Rathi, 2006; Sharholy et al., 2005; Ray et al., 2005). Generally, MSW is disposed of in low-lying areas without taking any precautions or operational controls. Therefore, MSWM is one of the major environmental problems of Indian megacities. It involves activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid wastes. But, in most Green cities, the MSWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. The management of MSW requires proper infrastructure, maintenance and upgrade for all activities. This becomes increasingly expensive and complex due to the continuous and unplanned growth of urban centers. The difficulties in providing the desired level of public service in the urban centers are often attributed to the poor financial status of the managing municipal corporations (Siddiqui et al., 2006; Raje et al., 2001; Ahsan, 1999). In the present study, an attempt has been made to provide a comprehensive review of MSWM for Indian Green cities to evaluate the current status and identify the problems of MSWM. The study also aims at encouraging competent authorities/researchers to work towards the improvement of the present system through suggestions and recommendations.

QUALITATIVE AND QUANTITATIVE ANALYSIS OF MSW

There are many categories of MSW such as food waste, rubbish, commercial waste, institutional waste, street sweeping waste, industrial waste, construction and

demolition waste, and sanitation waste. MSW contains recyclables (paper, plastic, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines), compostable organic matter (fruit and vegetable peels, food waste) and soiled waste (blood stained cotton, sanitary napkins, disposable syringes) (Jha et al., 2003; Reddy and Galab, 1998; Khan, 1994). The quantity of MSW generated depends on a number of factors such as food habits, standard of living, degree of commercial activities and seasons. Data on quantity variation and generation are useful in planning for collection and disposal systems. With increasing urbanization and changing life styles, Indian Green cities now generate eight times more MSW than they did in 1947. Presently, about 90 million t of solid waste are generated annually as byproducts of industrial, mining, municipal, agricultural and other processes. The amount of MSW generated per capita is estimated to increase at a rate of 1–1.33% annually. A host of researchers (Siddiqui et al., 2006; Sharholy et al., 2005; CPCB, 2004; Khan, 1994) have reported that the MSW generation rates in small towns are lower than those of metro cities, and the per capita generation rate of MSW in India ranges from 0.2 to 0.5 kg/ day. It is also estimated that the total MSW generated by 217 million people living in urban areas was 23.86 million t/yr in 1991, and more than 39 million t in 2001. The quantity of MSW generated (CPCB, 2000) and the per capita generation rate of MSW (CPCB, 2004) is shown in Table 1 and Fig. 1, respectively. It can be seen from Table 1 and Fig. 1 that the per capita generation rate is high in some states (Gujarat, Delhi and Tamil Nadu) and cities (Madras, Kanpur, Luck now and Ahmadabad).

Table 1 Municipal solid waste generation rates in different states in India

S. No.	Name of the state	No. of cities	Municipal population	Municipal solid waste (t/day)	Per capita generated (kg/day)
1	Andhra pradesh	32	10,845,907	3943	0.364
2	Assam	4	878,310	196	0.223
3	Bihar	17	5,278,361	1479	0.280
4	Gujrat	21	8,443,962	3805	0.451
5	Haryana	12	2,254,353	623	0.276
6	Himachal pradesh	1	82,054	35	0.427
7	Karnatka	21	8,283,498	3118	0.376
8	Kerala	146	3,107,358	1220	0.393
9	Madhya Pradesh	23	7,225,833	2286	0.316
10	Maharashtra	27	22,727,186	8589	0.378
11	Manipur	1	198,535	40	0.201
12	Meghalaya	1	223,366	35	0.157
13	Mizoram	1	155,240	46	0.296
14	Orissa	7	1,766,021	646	0.366
15	Punjab	10	3,209,903	1001	0.312
16	Rajasthan	14	4,979,301	1768	0.355
17	Tamil Nadu	25	10,745,773	5021	0.467
18	Tripura	1	157,358	33	0.210
19	Uttar Pradesh	41	14,480,479	5515	0.381
20	West Bengal	23	13,943,445	4475	0.321
21	Chandigarh	1	504,094	200	0.397
22	Delhi	1	8,419,084	4000	0.475
23	Pondichery	1	203,065	60	0.295
		299	128,113,865	48,134	0.376

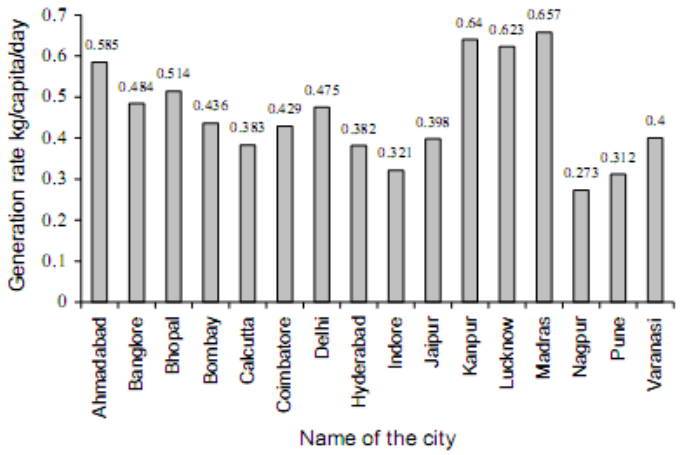

Fig. 1 Per capita generation rate of MSW for Indian Green cities

This may be due to the high living standards, the rapid economic growth and the high level of urbanization in these states and cities. However, the per capita generation rate is observed to be low in other states (Meghalaya, Assam, Manipur and Tripura) and cities (Nagpur, Pune and Indore).

STORAGE AND COLLECTION OF MSW

Storage of MSW at the source is substantially lacking in most of the urban areas. The bins are common for both decomposable and non-decomposable waste (no segregation

of waste is performed), and the waste is disposed at a communal disposal center. Storage bins can be classified as movable bins and fixed bins. The movable bins are flexible in transportation but lacking in durability, while the fixed bins are more durable but their positions cannot be changed once they have been constructed (Nema, 2004; Malviya et al., 2002).

In most Green cities, a fraction of MSW generated remains uncollected on streets, and what is collected is transported to processing or disposal sites. The collection efficiency is the quantity of MSW collected and transported from streets to disposal sites divided by the total quantity of MSW generated during the same period. Many studies on urban environment have revealed that MSW collection efficiency is a function of two major factors: manpower availability and transport capacity. The average collection efficiency for MSW in Indian Green cities and states is about 70%, as shown in Fig. 2 and Table 2 (Rathi, 2006; Siddiqui et al., 2006; Nema, 2004; Maudgal, 1995; Khan, 1994). Table 2 and Fig. 2 show that the collection efficiency is high in the cities and states, where private contractors and NGOs are employed for the collection and transportation of MSW.

Most of the Green cities are unable to provide waste collection services to all parts of the city. Generally, overcrowded low-income settlements do not have MSW collection and disposal services. The reason is that these settlements are often illegal and the inhabitants are unwilling or unable to pay for the services.

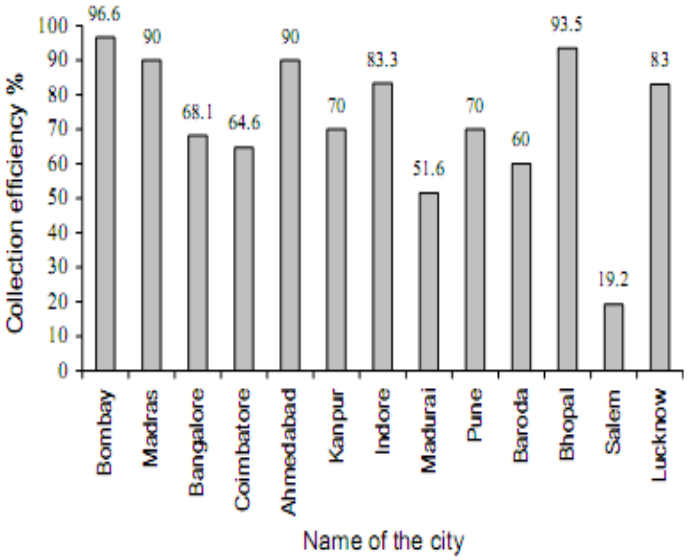

Fig. 2 Collection efficiency of MSW for Indian Green cities

Table 2 Per capita generation, disposal and collection efficiency of MSW for Indian state

State	Per capita generation (g/cap/day)	Per capita disposal (g/cap/day)	Collection efficiency (%)
India (sample average)	377	273	72
Andhra Pradesh	346	247	74
Bihar	411	242	59
Gujarat	297	182	61
Haryana	326	268	82
Karnataka	292	234	80
Kerala	246	201	82
Madhya Pradesh	229	167	73
Maharashtra	450	322	72
Orissa	301	184	61
Punjab	502	354	71
Rajasthan	516	322	62
Tamil Nadu	294	216	73
Uttar Pradesh	439	341	78
West Bengal	158	117	74

They throw away the waste near or around their houses at different a time, which makes the collection and transportation of waste very difficult in these areas. The Central Pollution Control Board (CPCB) has collected data for the 299 Class-I Green cities to determine the mode of collection of MSW. It is found that manual collection comprises 50%, while collection using trucks comprises only 49% (CPCB, 2000).

TRANSFER AND TRANSPORT OF MSW

Transfer stations (except in a few cases as in Madras, Mumbai, Delhi, Ahmadabad and Calcutta) are not used, and the same vehicle, which collects refuse from individual dustbins, takes it to the processing or disposal site (Khan, 1994). The MSW collected from the dustbins and collection points is transported to the processing or disposal sites using a variety of vehicles. In smaller (rural) towns, bullock carts, tractor-trailers, tricycles etc., are mainly used for the transportation of MSW. Light motor vehicles and Lorries are generally used in big towns or cities for transport of MSW. The trucks used for transportation of MSW are generally of an open body type and are usually kept uncovered; thus during transportation, the waste tends to spill onto the road resulting in unhygienic conditions. In some Green cities, modern hydraulic vehicles are gradually being introduced. Collection and transportation activities constitute approximately 80–95% of the total budget of MSWM; hence, it forms a key component in determining the economics of the entire MSWM system. Municipal agencies use their own vehicles for MSW transportation although in some Green cities they are hired from private contractors (Siddiqui et al., 2006; Nema, 2004).

MSWM RULES IN INDIA

The Ministry of Environment and Forest (MoEF) of the government of India has issued MSW (management and handling) rules in the year 2000 for scientific MSWM, ensuring proper collection, segregation, transportation, processing and disposal of MSW and upgrade of the existing facilities to arrest contamination of soil and ground water. As per the provision, CPCB has been assigned to monitor the implementation of these rules, and the municipalities will be required to submit annual reports regarding the status of MSW in their areas to the CPCB. These rules are applicable to every Municipal Authority in India, which is responsible for MSWM. In addition, there are Municipal Corporation Acts by different states such as the Delhi Municipal Corporation Act 1959, Uttar Pradesh Municipal Corporation Act 1959 and Karnataka Municipal Corporation Act 1976. These Acts also deal with environmental pollution caused by improper disposal of MSW, for example The Delhi Plastic Bag (Manufacture, Sales and Usage) and non-biodegradable garbage (control) Act, 2000, was enacted to prevent contamination of foodstuff carried in recycled plastic bags, reduce the use of plastic bags, throwing or depositing non-biodegradable garbage in public drains, roads and places open to public view. Local authorities often see MSWM as a poor service compared to other basic services because MSWM can barely recover operating costs. However, most of the municipalities are unable to provide the desirable level of conservancy services. Due to a number of problems, they have not been very effective as far as SWM services are concerned (Siddiqui et al., 2006).

CONCLUSION

The informal policy of encouraging the public to separate MSW and market it directly to the informal network appears to be a better option. The involvement of people and private sector through NGOs could improve the efficiency of MSWM. Public awareness should be created among masses to inculcate the health hazards of the wastes. Littering of MSW should be prohibited in Green cities, towns and urban areas notified by the state government. Moreover, house-to-house collection of MSW should be organized through methods like collection on regular pre-informed timing and scheduling. The collection bins must be appropriately designed with features like metallic containers with lids, and to have a large enough capacity to accommodate 20% more than the expected waste generation in the area, with a design for mechanical loading and un-loading, placement at appropriate locations, etc. Municipal authorities should maintain the storage facilities in such a manner that they do not create unhygienic and unsanitary conditions. Proper maintenance of the MSW transportation vehicles must be conducted, and the Dumper Placer should replace the old transportation vehicles in a phased manner. Currently, at the level of waste generation and collection, there is no source segregation of compostable waste from the other non-biodegradable and recyclable waste. Proper segregation would lead to better options and opportunities for scientific disposal of waste. Recyclables could be straightway transported to recycling units that in turn would pay a certain amount to the corporations, thereby adding to their income. This would help in formalizing the existing informal set up of recycling units. It could lead to several advantages such as enabling technology up gradation, better quality products, saving of valuable raw material resources of country, reducing the need for landfill space, a less energy-intensive way to produce some products and employing labor in recycling industries. Organizing the informal sector and promoting micro-enterprises are an effective way of extending affordable services. Promotion and development of recycling is a means of upgrading living and working conditions of rag pickers and other marginalized groups. Most of the MSW in India is dumped on land in an uncontrolled manner. A new survey should be carried out on the generation and characterization of MSW in India. Finally, the study concluded that the lack of resources such as financing, infrastructure, suitable planning and data, and leadership, are the main barriers in MSWM. The increase of service demands combined with the lack of resources for municipalities are putting a huge strain on the existing MSWM systems.

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