Sustainable Municipal Solid Waste Management in Emerging Mega Cities:
A Case study of Surat (Gujarat) City.

Jemish Bhanubhai Lathiya[a]

[a] **Department of Architecture & Interior Design, Shantaben Manu Bhai Patel school Studies and Research in Architecture & Interior Design (SMAID),New Vallabh Vidyanagar(Anand), Gujarat, India.**

Keywords: Municipal Solid Waste, Industrialization, population explosion, waste treatment, Strategic and financial Aspects

Abstract:

Waste is an unavoidable byproduct of human activities. Economic development, urbanization And improving living standards in cities, have led to an increase in the quantity and complexity of generated waste. Rapid growth of population and industrialization degrades the urban Environment and places serious stress on natural resources, which undermines equitable and sustainable development inefficient management and disposal of solid waste is an obvious cause of degradation of the environment in most of the cities of the developing world. Municipal corporations of the developing countries are not able to handle increasing quantities of waste, which results in uncollected waste of roads and in other public places. There is a need to work towards a sustainable waste management system, which requires environmental, institutional, financial, economic and social sustainability.

The purpose of Municipal Solid Waste management (MSW) system is to improve the present practices of MSW in that prevail in many developing countries where it has received sufficient Attention.

This paper describes the present scenario of the SWM practices carried out in the emerging Mega city - Surat City. It also describes the solid waste collection, transportation, treatment and disposal methodology adopted in Surat city.

1.0 Introduction:

Solid waste has become one of the biggest problems and its management is one of the major issues now days for our environment. The problem is not restricted**.** To a single place rather it covers all parts of the environment which leads to toxic pollutants. Developing countries face major problem i.e. solid Waste management in urban as well as in rural areas. The most obvious environmental damage caused by Solid waste is aesthetic. A more serious risk is the transfer of pollution to ground water and land as well as the pollution of air from improper burning of waste.

The most common problems associated with improper management of solid waste include diseases, odor nuisance, fire hazards, atmospheric and water pollution, aesthetic nuisance and economic losses (Jilani, 2002). There has been a significant increase in solid waste generation in India over the years from 100 gm per person per day in small towns to 500 grams per persons per day in large towns. Currently most of the municipal waste in India is being disposed unscientifically (Akolkar, 2005).

Generally municipal solid waste is collected and deposited in landfill such unscientific disposal attract birds, rodents and fleas to the waste site and create unhygienic conditions (Suchitra, et al. 2007).

1.1 Surat City profile

Surat is the biggest trade hub in Gujarat and is one of the fastest growing cities in terms of Infrastructure and urban development. It is located at a distance of about 250 Km. North of Mumbai on the banks of river Tapi. The city flourished due to its nearness to Mumbai. The City spurt to a highly dense population during the early 60's followed by a series of urban Agglomerations as a number of peripheral urban villages were included in the Surat Municipal Corporation (SMC) area. The demographic profile of SMC is illustrated in table 1.

Table 1: Demography of Surat City

Sr. No.	Year	Population	SMC Area
1	1961	2,88,026	8.18
2	1971	4,71,656	33.80
3	1981	7,76,583	55.56
4	1991	14,98,817	111.16
5	2001	24,33,835	112.28
6	2011	44,61,026	326.52

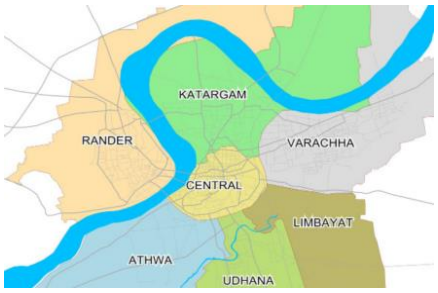


Figure 2: Zonal Map of Surat City

In Surat city primary sources of solid waste are local households, commercial establishments, hospitals, hotels, restaurants, and markets. The total quantity of waste generated per day is about 1400 metric tons. Surat Municipal Corporation (SMC) is responsible for collection, storage, segregation, transportation and disposal of all solidwaste generated in the city. In the present Study work describe an attempt to assess the collection, segregation, transportation, treatment and Disposal of Surat Municipal Corporation Landfill Site.

1.2 Characteristics of Municipal Solid Waste:

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-Mew contains recyclable (paper, plastic; glass and metal etc.), toxic substances (paints, pesticides, used batteries, medicines etc.) compostable organic matter (fruit and vegetable peels, food waste) soiled waste (blood stained cotton, sanitary napkins, disposable syringes).

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. Indian cities now generate eight times more MSW than they did in 1947 because of increasing urbanization and changing life styles [14]. The rate of increase of MSW generated per capita is estimated at 1 to 1.33% annually [15-16]. 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 was 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 ton in 2001 [18-22]. The Central Pollution Control Board (CPCB) had conducted a survey of solid waste management in 299 cities and has given the data (Table-1) of waste generation for different cities.

Table 2: The Quantity of Municipal Solid Waste

Sr. No.	Name of the State	No. of Cities	Municipal Population	Municipal Solid Waste(t/day)	Per Capita Generated (Kg/day)
1	Andhra Pradesh	32	10,84,5907	3973	0.364
2	Assam	4	8,78,310	196	0.223
3	Bihar	17	52,78,361	1479	0.280
4	**Gujrat**	**21**	**84,43,962**	**3805**	**0.451**
5	Haryana	12	22,54,353	623	0.276
6	Himachal Pradesh	1	82,054	35	0.427
7	Karnataka	21	82,83,498	3118	0.376
8	Kerala	146	31,07,358	1220	0393
9	Madhya Pradesh	23	72,25,833	2286	0.316
10	Maharashtra	27	2,27,27,186	8559	0.378
11	Manipur	1	1,98,535	40	0.201
12	Meghalaya	1	2,23,366	35	0.157
13	Mizoram	1	1,55,240	46	0.296
14	Orissa	7	17,66,021	646	0.366
15	Punjab	10	32,09,903	1001	0.312
16	Rajasthan	14	49,79,301	1768	0.355
17	Tamil Nadu	25	1,07,45,773	5021	0.467
18	Tripura	1	1,57,358	33	0.210
19	Uttar Pradesh	41	1,44,80,479	5515	0.467
20	West Bengal	23	1,39,43,445	4475	0.321
21	Chandigarh	1	5,04,094	200	0.397
22	Delhi	1	84,19,084	400	0.475
23	Pondicherry	1	2,03,065	60	0.295
Total		**299**	**12,81,13,865**	**48,134**	**0.376**

Source- Status of MSW generation, collection, Treatment and disposal in cities-I (CPCB, 2000).

Currently Surat city is generating around 1400 metric tons of solid waste per day, which is Collected, transported and disposed at a sanitary landfill site which is about 20Km away from Surat. The total cost for collection, transportation and disposal High Budget are spent on Transportation and Equipment's used at the Sanitary landfill site.

1.3 COMPOSITION OF MSW

Materials in MSW can be broadly categorized into three groups, Compostable, Recyclables and Inerts. Compostable or organic fractions consist of market wastes and food waste. Recyclables are included paper, plastic, glass and metal. The fraction of MSW which can neither be composted nor

recycled into secondary raw materials is called Inert. Inert material includes stones, ash and silt which enter the collection system due to littering on streets and at public places.

1.4 MSW GENERATION

Generation of MSW has an obvious relation to the population of the city, caused by bigger cities generate more waste. Kolkata metropolitan area generates the largest amount of MSW (11,520 TPD or 4.2 million TPY) among Indian cities.

Municipal Waste is generated as Dry Waste and Wet Waste. It is observed that the previous literature tropical countries show the higher percentage of wet waste than dry. Surat city generates dry and wet waste approximately in equal proportion (i.e. 50%-50%). The garbage generated is dependent on the activity prevalent in the area where as wet waste generation is more in residential and commercial area such as hotels or food industry.

Table 3: Quantity of Waste Generated in SMC

Sr. No.	Sources	Percentage %
1	Households	53
2	Shops	16
3	Vegetable/ Fruit/ Meat/ Fish Market	14
4	Construction & Demolition material	8
5	Biomedical waste	1
6	Hotel/ Restaurant waste	8
	Total	100

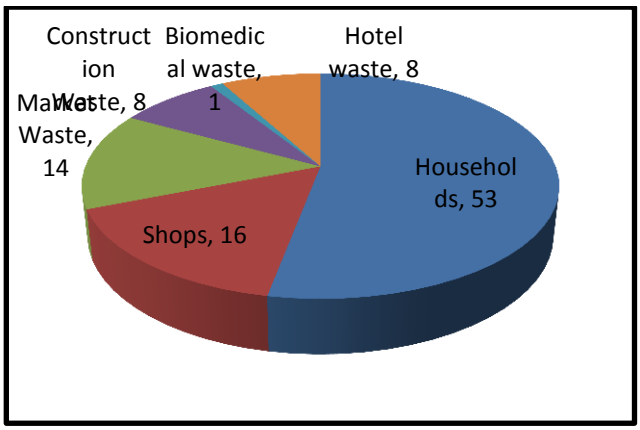


Figure 2: Sources of MSW Generation in SMC.
Source- Surat City Development Plan (2006-2012)

The total waste generated is in the range of 1300 to 1400 metric tons (MT) per day (per capita of 400 grams per day). The waste generated was collected, transported and disposed at land fill site which is about 15 km away from Surat at Khajod.

2.0 The main components of waste management are collection, segregation, Storage, Transportation, Treatment and Disposal. Currently, most of the cities MSWM system includes above mention all components of waste management.

1. **Collection**
2. **Transportation**
3. **Segregation**
4. **Treatment**
5. **Disposal**

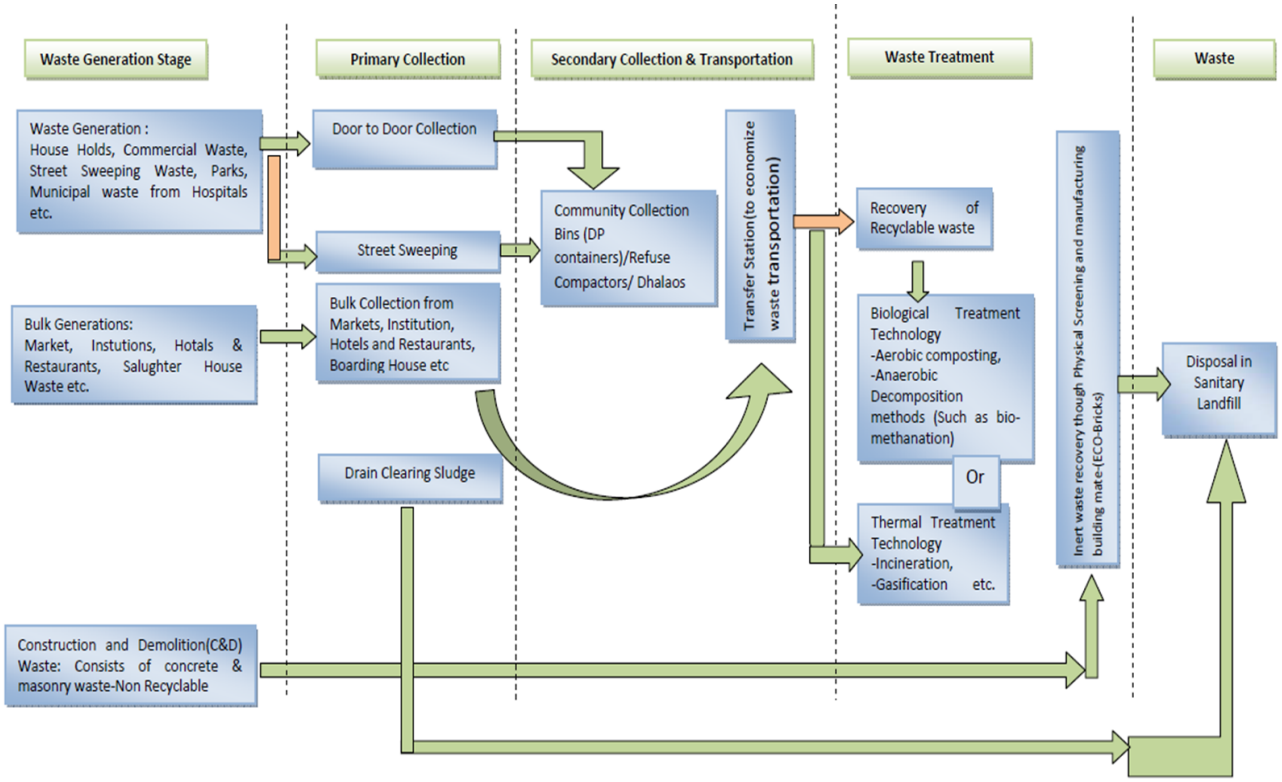


Figure 1: Stage of Waste Generation, Collection, Transport and Disposal as per Guideline Mentioned in the SWM Toolkit given by Urban Development Ministry, Government of India.

3.1 Waste Collection:

The waste collection methods that are mainly adopted in India are Door-Door Collection. Waste collection is the removal of waste from houses and all commercial places to collection site from where it will go for further treatment or disposal. The Corporation organizes the collection and transportation through a team of its own conservancy workers and a fleet of vehicles and dumper-placers. The waste is also collected with the help of rag pickers by carrying out door-to-door collection in certain areas; these rag-pickers are not the employees of SMC, but they make their livelihood by salvaging recyclable waste from collection points and dump.

Table 4: SWM Collection yearly data by SMC.

Year	Primary Collection							
	Container				Door to Door			
	No. of Container Sports	No. Vehicle	No. Trips per day	MSW Lifted per day(MT)	No. Vehicles	No. Trips per day	MSW Lifted per day	MSW Disposal per day(MT)
2004-05	1548	65	775	750.000	95	255	210.168	1078.118
2005-06	1290	61	600	580.000	125	317	296.306	1010.463
2006-07	1247	61	580	560.000	180	442	447.595	1689.941
2007-08	1193	63	555	502.000	213	514	584.006	1093.719
2008-09	1120	60	500	430.000	225	568	644.626	1121.208
2009-10	1120	61	490	409.000	238	578	649.716	1076.783

2010-11	1120	65	515	486.000	238	566	617.229	1152.732

Sources: - Report of Co-benefits of Waste Management: A Case of Surat, India by School of Planning And Architecture, Bhopal, India.

The collection efficiency ranges between 70 to 90% in major cities whereas in several smaller cities the collection efficiency is below 60%. Street sweeping is another type of collection method for the collection of street litter; many cities spend 30-50 % of their solid waste budgets on street cleansing.

Image 1/2/3: Primary Collection: Door to Door Collection, Street Sweeping.

3.1.1 Problems in Implementing Door to Door Collection.

- Primary collection system (door to door collection) is not efficient Coverage is only 65 - 70%.
- There is lot of complaints from citizens regarding lack of proper door to door garbage collection services.
- The collection vehicles are not properly designed and cannot be used at all areas and Places.
- The storage depots are not evenly distributed. In some wards, they are available in large numbers and are very close to one and another, on the other areas; they are far apart, thus making sweepers difficult and time consuming for the working on the sites.
- The storage depots are not evenly distributed. In some wards, they are available in large numbers and are very close to one and another, on the other areas; they are far apart, thus making sweepers difficult and time consuming for the working on the sites

3.2 Waste Segregation

Segregation at source is the most important step in waste management and is done in two major categories: wet waste and dry waste. Wet waste is the bio degradable solid waste includes residential waste of all kinds and waste from markets and slaughterhouse. Dry waste is the recyclable solid waste that includes paper and plastic of all kinds excluding hazardous waste material.

Waste segregation was made mandatory by Hon. Supreme court and Govt. of India Gazette dated 3rd October 2001 and Municipal solid waste management and handling rules 2000. SMC has implemented solid waste segregation system for dry and wet waste in the city.

3.3 Transportation of Solid Waste

The transportation of waste is the Solid waste from each collection point is brought to transfer Stations by Dumper place or other transportation equipment. Before sending the waste to the Disposal site at Khajod, the entire waste is send to transfer stations for weighting and the same Computerized record is maintained by authority.

Table 5: SWM Collection yearly data by SMC.

Sr.No.	Name of transfer Station	Zones
1	Bhatar	South West
2	Katargram	North & central
3	varachha	East
4	Anjana	South- East
5	Pal	West
6	Bhestan	South

Sources: - Website of "Surat Municipal Coro."

The process of Waste transportation is very dirty, smelly and unhygienic. The process of waste loading & Disposal is time consuming, labour Intensive and high Health Risks to the workers.

Municipality are not following the waste transportation norms like- transporting waste under covered conditions so that littering does not occur. The transportation of MSW needs attention under the technology and Governance aspects of Integrated Solid Waste Management System.

Image 4: Transfer Station in Surat

Image 5: Tipping Platform at Surat Transfer Station

Image 6 :Dumping sight - Khajod

3.3.1 Problems with transportation:

- Relatively large number of vehicles are deployed for transportation
- Heavy fuel expenditure.
- Vehicles are routine such as trippers, trucks, dumper placers etc not sophisticated modern such as compactors
- Relatively large numbers of labors are engaged.
- More vehicles mean more operation and maintenance and fuel and labour cost.

- Issue of fuel and log book entry is done manually thus leaving scope for manipulation on the part of drivers and cleaners. Software has been recently prepared by NIC and is in the stage of testing.

3.4 Processing and Scientific Disposal of Waste

At present all the Garbage thus collected from the city is disposed in Open in Dump yard by way of landfill without proper processing. There is some Facility for processing of Garbage but it is not so scientific and sufficient. Hence most of the Garbage is Dumped without processing.

3.4.1 Problems with Processing of SWM at Dump yard

- No Scientific processing
- Open Dumping
- Problem odour and flies
- Opposition from the nearly Localities

3.5 Social awareness and participation

The role of Society is a key to Managing solid waste. It is important to create awareness in the Society, to change the conventional habits of treating the waste. Education to masses, motivation to Society groups and willingness of public are the rules of any awareness programmer. The management of waste indeed gets successful it starts at the sources itself. The role of community only gets start from here. If generation of waste is prevented, the Problem reduced to several folds itself. Waste prevention is fairy a new term and waste Framework Directive (WFD)(2008/98/EC) it can be defined as "the measure taken before a substance, material or product has become waste, that reduce the quantity of waste, the adverse impacts of the generated waste on environmental and human health or the content of harmful substances(Zorpas and lasaridi,2013). There can be simple ways by which community can help in preventing the generation of waste.

- The generation of waste can be minimized by promoting the use of recyclable, biodegradable or washable materials. It will lower down the burden on the waste management system by red ucing the quantity of waste-needs to be disposed. The reuse of existing products or packing can help in waste minimization.
- The efficiency of management system can be enhanced with the help of community if proper segregated and storage waste is maintained. The segregated waste is easy to process and it required less labour and cost. Further handing of such waste is also not harmful for workers and pickers.

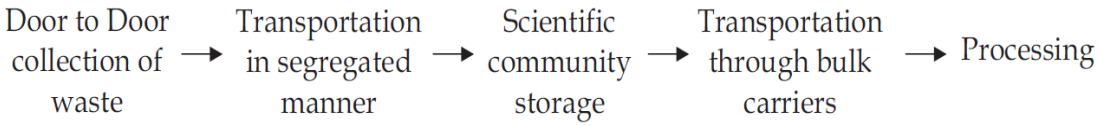
Around 19% of Surat's population is staying below poverty line and there is lack of knowledge regard ing the consequences of unhealthy solid waste management practicesHere, the roleof health care socie ties, self-help groups, NGOs is significant to run routine programmes in each
community for creating awareness.

3.6 Recommendation:

Legislation concerning waste is usually differentiated according to the type of waste. International conventions often cover nuclear and hazardous waste, whereas non-hazardous waste, often called

solid waste is usually more regulated at the national level. From an environmental angle the following rules, regulations and acts would be relevant for MSWM:

- **Municipal Solid Waste (Management & Handling) Rules 2000**, notified by the Ministry of Environment and Forests, Government of India vide notification no. S.O.908 (E) dated 25th Sept. 2000. The guidelines given in this law cover all the functional elements of municipal solid waste management.
- **The Water (Prevention and Control of Pollution) Act, 1974,** Two aspects have to be kept in mind with regard to MSWM. Firstly, consent from the state pollution control board for establishment of a sanitary landfill site and compost plant is essential and secondly, no water pollution should be caused by the leachate that is emitted by the sanitary landfill site or a compost plant.
- **The Water (Preventing and Control of Pollution) Cess Act, 1977**, and amendments thereon. The only aspect that should be considered in this law in regard to MSWM is provision for levying and collection of cess on water consumed for the sanitary land filling, composting and anaerobic digesters.
- **The Air (Prevention and Control of Pollution) Act, 1981,** The aspects to be considered in this law with respect to MSWM is the need for obtaining consent from the State Pollution Control Board for establishment of processing plants and disposal sites and from an environmental aspect with regard to the pollution caused by incineration plants, compost plants and landfill sites.
- **The Environment (Protection) Act, 1986 and its subsequent notifications.** The notification with regard to MSWM states that for any project to be authorized an EIA (Environment Impact Assessment) report should be submitted first. The following diagram shows the chain of MSWM:



- **All the acts mentioned above if followed 100% will lead to waste managed environment further more leading to a habitable or Sustainable development.**

4.0 Conclusion:

Solid waste management has become a very important component of urban development if urbanization in India has to be properly planned. Looking to the quantum of solid waste generation and its adverse impact on health and environment, enough resources are to be allocated for this sector. Unfortunately in India we are not prepared for all the steps of MSWM i.e. from door to door collection to ultimate disposal through processing. As on today we have adopted the policy of shifting waste from one place to another. Time is ripe to take a view in totality where not only collection and transportation is focused but also the minimizing of landfills is also planned. Cities can only be imagined as clean and sanitized when we lay enough emphasis on all aspects of solid waste management.

References:

1. Mundhe, Nitin.” Assessment of Municipal Waste Management of Pune city using Geospatial Tools”. International Journal of Computer Application (0975-8887) Volume 100-No.10, August 2014.

2. Gidde, M.R.” Municipal Solid Waste Management in Emerging Mega Cities: A Case of Pune City.” Indo Italian conference on green and clean Environment March 20-21, MAEER’s MIT College of Engineering, Pune.
3. Kumar, Vijay.” Problems of Solid Waste Management in Indian Cities. “International Journal of Scientific and Research Publications, Volume 3, March 2013.
4. Gupta, Ruchi. “Cross Functional Team for Integrated Solid Waste Management (ISWM) Practices: An Approach Suitable for India and Other Developing Country.” Advances in Energy Engineering (AEE) Volume 2, 2014.
5. Yadav, K.D. “Evaluation of collection and transportation of Municipal Solid Waste Management System in JnNURM cities in Gujarat, India: A Case study of Ahmedabad, Surat, Vadodara and Rajkot.” IJSR- International Journal of Scientific Research, Volume 2, July 2013: Page 185.
6. Dhanjani, Jitendra, “Collection and Transportation of Municipal Solid Waste in India- an Analysis.” Journal of Development Management, Volume 1, No. 1, January-March, 1013.
7. Report of Surat’s JnNURM Project Implementation Unit (PIU), Ministry of Urban Development.
8. “Co-Benefits of Waste Management: A Case Of Surat, India.” School Of Planning And Architecture, Bhopal, India.