MUNICIPAL SOLID WASTE MANAGEMENT IN CHENNAI CITY, INDIA

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SUMMARY: Municipal Solid Waste Management (MSWM) is a challenging problem for developing countries. Municipal Solid Waste (MSW) generation in Chennai, the fourth largest metropolitan city in India, has increased from 600 to 3500 tons per day (tpd) within 20 years. The highest per capita solid waste generation rate in India is in Chennai (0.6 kg/d). Chennai is divided into 10 zones of 155 wards and collection of garbage is carried out using door-to-door collection and street bin systems. The collected wastes are disposed at open dump sites located at a distance of 15 km from the city. Recent investigations on reclamation and hazard potential of the sites indicate the need for the rehabilitation of the sites. Chennai is the first city in India to contract out MSWM services to a foreign private agency- ONYX, a Singapore based company. The scope of privatization includes activities such as sweeping, collection, storing, transporting of MSW and creating public awareness in three municipal zones. ONYX collects about 1100 Metric tons of waste from three zones per day and transports it to open dumps. Various Community Based Organizations (CBO) are also involved in the MSWM of the city. A high rate biomethanation plant for power generation is in operation at the Koyembedu market. Total cost for street sweeping, collection and transportation per Metric ton of waste by Corporation of Chennai (CoC) and Onyx is approximately USD 33 and 25, respectively.

1. INTRODUCTION

Municipal Solid Waste includes commercial and residential wastes generated in municipal or notified areas, in either solid or semi-solid form excluding industrial hazardous wastes, but including treated bio-medical wastes (MoEF, 2000).

The quality and quantity of MSW generated by a particular community will vary according to their socio-economic status, cultural habits, urban structure, population and commercial activities. Asian countries are facing MSWM problems due to the rapid growth in MSW generation rate. The total quantity of waste generated by 23 metro cities in India was 30,000 tpd in 1999, which has increased considerably to about 52,000 tpd (Inance et al, 2004). Government bodies at all levels (central, state and municipal) are taking proactive steps to improve the municipal solid waste scene in India. The Government of India issued new rules that regulate the

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MSWM (MoEF, 2000) at the local level. The mandatory requirements of the rule are,

- Source segregation and storage at source
- Door to door collection
- Abolition of open storage
- Daily sweeping of the street
- Transportation of waste in covered vehicles
- Waste processing by composting or energy recovery
- Disposal of inerts by sanitary landfilling

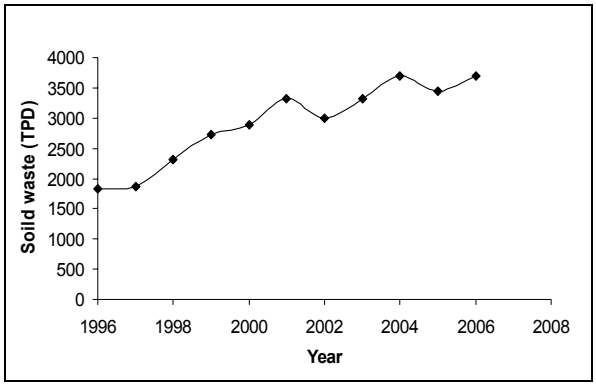
State governments are involved through the State Pollution Control Boards (SPCBs) which enforce pollution control laws and local municipalities to comply with the new rules.

Chennai (formerly Madras), is the fourth largest metropolitan city in India. It is the capital of the State of Tamil Nadu and located on the eastern coast (Latitude 13^{o} 07' N and Longitude 80^{o} 16' E). Total area of the city is 174 sq.km with a current population nearing 6 million. The city has also attained the status of Mega city (NPC, 2005). MSW generation in Chennai has increased from 600 to 3500 tpd within 20 years. The per capita generation rate is 0.6 kg/day. MSWM is the primary function for CoC. This includes the street sweeping, collection, transportation and disposal of MSW from the city limit. Chennai is divided in to ten zones (Figure 1). There are three different organizations namely the CoC, ONYX and CBOs such as Civic Exnora are involved in the MSWM of the city. The paper presents the quantity and quality of the waste generated, collection, transportation and disposal details and the initiatives to improve MSWM in Chennai.

2. SOLID WASTE GENERATION

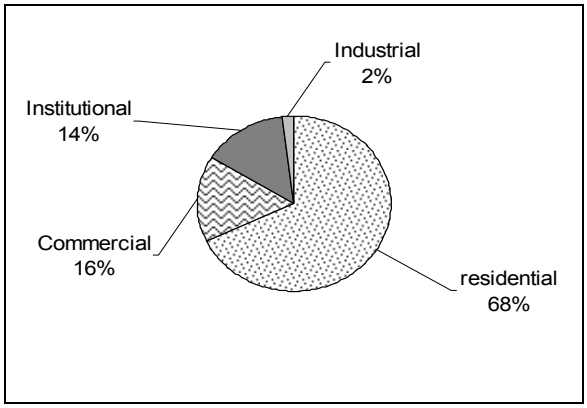
Population growth and rising income have resulted in a rapid growth in MSW generation rate of the city. Figure 2 presents the increase in average quantity of waste collected per day for the period of 1996 to 2006. Waste generation per day has been doubled during the last decade.

Figure 1. Zonal Map of Chennai City



Source: www.chennaicoproration.com

Figure 2. Rapid Growth in Generation of MSW



Source: www.chennaicoproration.com

Figure 3. Sources of MSW in Chennai

MSW generated in Chennai includes 68 % of residential waste, 16 % commercial waste, 14 % institutional waste and 2 % industrial waste (Figure 3). The physico-chemical properties of the MSW generated in Chennai, showed that the majority of the waste is composed of green waste (32.3%) and inert materials (34.7%) *viz.*, stones and glass (CPCB, 2000 and Damodaran et.al., 2003).

3. INSTITUTIONAL FRAMEWORK

Solid Waste Management of the city is the joint responsibility of the Superintending Engineers of Mechanical and SWM Departments of CoC, with the Assistant commissioners of all the 10 zones. The organizational set up of the MSWM system and the operational chart at zonal level are given in Figure 4.

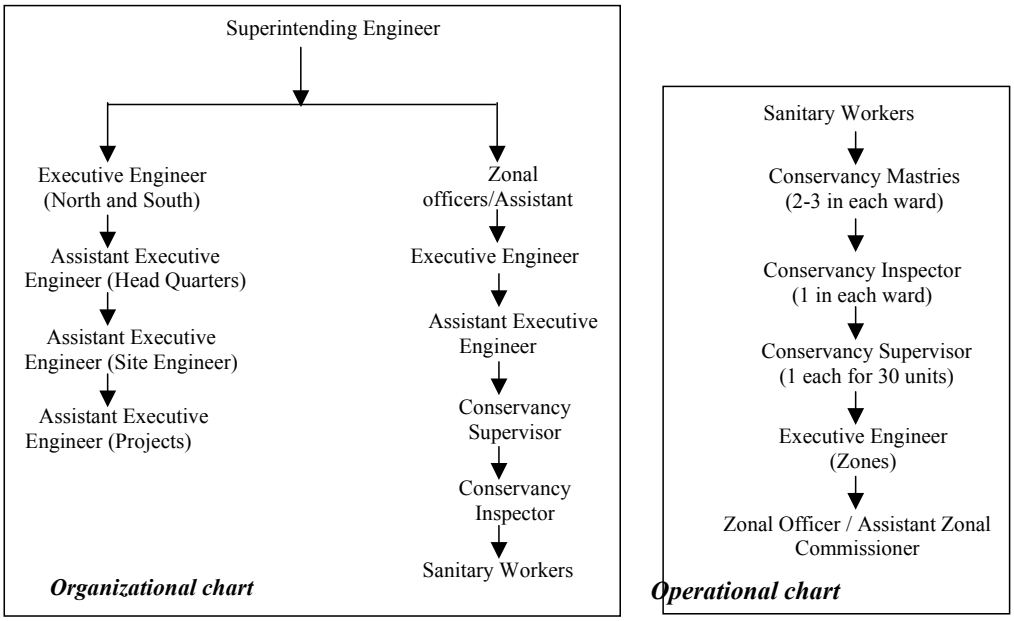


Figure 4. Municipal Solid Waste Management Organization and Operation Chart

MSWM in Chennai has been privatized in zones 6, 8 and 10. These three zones cover one third of the total area of the city. CoC looks after the other seven zones. The solid waste generated are collected, treated and disposed into the open dumpsites at Perungudi and Kodungaiyur. The waste is tipped at the site and leveled by bulldozers. These sites are located at 15 kms on either side (south and north) from the centre of the city. Total number of workers i.e, conservancy inspector, maintenance staff, time keeper and labourers involved in dumping ground operations are presented in Table 1.

4. SOLID WASTE MANAGEMENT BY CORPORATION OF CHENNAI

The CoC is undertaking MSWM for the seven zones (1, 2, 3, 4, 5, 7 and 9). The management of solid waste as stated in schedule II of the MSWM & Handling Rules (MoEF, 2000) has listed collection of MSW with emphasis on segregation at source and door to door collection. In compliance with the above rules, several attempts are underway to improve the MSWM in Chennai city (Figure 5). The initiatives include the following.

a. *Source Segregation* – It is introduced with a view to setting aside of biodegradable and recyclable materials from the waste stream before these are collected with the other MSW, to facilitate reuse, recycling and composting. Initially source segregation was introduced in a few zones by January 2004, and the facility was further extended to other zones. It was initiated with a public awareness campaign on source segregation of MSW during 2003. Corporation workers, zonal officers, revenue officers technical staff, teachers and school children were involved in this program. Non Governmental Organisations (NGO's) and members of local welfare associations (Civic Exnora) started their own campaign and helped in distributing the pamphlets prepared by the CoC. The awareness program comprised of public rallies, meetings, distribution of pamphlets, street plays and advertisements..

b. *Door to door collection* – Door to door collection is introduced to replace the street bin collection system with a view to reduce the environmental effects. Tricycles fitted with bells were used for MSW collection from doorsteps. The scheme was introduced in June 2003 and expanded throughout the city during January 2004.

c. *Abolition of open storage* – It is partially achieved by the removal of community bins from the streets. The number of street bins were reduced from 14,000 to 1,300 during November 2004. Due to the lack of financial resources, non co-operation of the population and inaccessible area/narrow lanes it is difficult to achieve 100% abolition of open storage.

d. *Daily sweeping of the street* –Corporation employees are engaged in sweeping the streets at least once in a day using brooms, brushes, rotomould wheeled bins, wheel barrow and long brooms. The major constraints in implementing daily street sweepings are shortage of sanitary workers, public holidays and lack of financial support.

Table 1. Work Force Involved in Dumping Ground Operations

Sl. No.	Manpower	Perungudi	Kodungaiyur
1	Conservancy Inspector	2	3
2	Maintenance Staff	2	3
3	Time Keeper	1	3
4	Workmen	34	67

Source: www.chennaicoproration.com

e. *Transportation in covered vehicles* - CoC has initiated the transportation of MSW in vehicles covered with fishnets to avoid spillage. Difficulties in using the covered vehicles for transportations are financial resource, insufficient number of vehicles and attitude of workers.

f. *Wastes processing by energy recovery or composting* - Ward level composting units were introduced in 106 places to reduce the transportation cost of MSW and the amount of waste reaching dumpsite. The segregated waste is collected and the organic fraction is subjected to composting in ward level composting units, whereas the non-recyclable fraction is transported to the dumpsites for disposal. There were proposals to recover energy from the waste and composting of organic fractions in centralized mechanical composting units. These projects are yet to be implemented.

g. *Sanitary landfilling* - According to Environmental Resource Management suggestions (ERM 1996), the open dump sites are in operation for the past 20 years and their lifetime is expected to last up to 2011, which can be extended to a further period by upgrading the existing sites. Based on the recent investigations CoC has initiated the upgradation process of Kodungaiyur dumpsite. The approach is a phase wise conversion of open dumpsite into a sanitary landfill as per the recommendation of the National Productivity Council (NPC, 2005).

It is difficult to fulfill the requirements of all the above aspects in developing countries like India, due to practical problems such as lack skilled personal for MSWM, administrative difficulties and public coordination.

5. PRIVATE SECTOR PARTICIPATION

Chennai is the first city in India to contract out MSWM services to a foreign agency. International tenders were called for by the CoC and a contract was signed with ONYX. The scope of the project includes the activities such as sweeping, collection, storing, transporting of MSW and creating public awareness on MSWM (Figure 6).

Awareness Campaign

Bins for Source Segregation

Collection at Door Step

Waste Transport

Figure 5. Municipal Solid Waste Management by Corporation of Chennai

Manual Sweeping

Mechanical Sweeper

Mechanized Collection Vehicles

Transfer Station

Figure 6. Private Sector in Municipal Solid Waste Management

Since March 2000, ONYX is responsible for the zones 6, 8 and 10. ONYX has 2,000 employees for its MSWM in the city. Their compactor can handle garbage of 7 to 8 tones. Movable bins are emptied once in a day and are cleaned every 15 days by the sanitation department. Sometimes even more often, depending on the amount of garbage collected. ONYX staff work on holidays and collects 1100 tones of waste from three zones per day and transports into Perungudi dumping ground (www.chennaibest.com).

The characteristic features of ONYX services are:

- Imported technologies for MSWM
- Containerization of household waste before collection
- Mechanization of handling tasks through lifting, compacting and tipping devices
- Day and night services of collection
- Professional equipment for collectors
- Better machinery, maintenance and relatively young work force
- Training program for workers
- Transfer system and haulage
- Transfer stations

Table 2, compares the infrastructure used, the manpower involved, collection rate and operational cost by CoC and ONYX for MSWM. CoC is managing 2000 tpd of MSW with the manpower of 10,000, including administrative staff and workers., while ONYX is managing 1100 tpd using 2,000 persons. Total cost for street sweeping, collection and transportation of one Metric ton waste by CoC and Onyx is approximately USD 33 and 25, respectively. So the privatization is beneficial for MSWM in terms of reduction in the waste collection cost to the tone of 8 USD/t.

6. WASTE PROCESSING

An agreement was made between the CoC and an Australian company to develop a waste to power plant through gasification technology in 2001. The plant has been proposed at Perungudi dumpsite at 15-acre plot of land for 15 years. The total project cost was estimated to be Rs. 180 cores and the project was proposed to produce 14.85 MW of electricity using 600 Metric tones of MSW per day. It failed due to the disagreements in the power purchase rate and also because of protests by the environmentalists (www.Toxicslinks.org 2001 and Srinivasan, 2005). Chennai Metropolitan Development Authority (CMDA) with the support of Ministry of Non-Conventional Energy Sources (MNES), Govt. of India has established a high rate biomethanation plant of 30 tpd capacity for power generation from vegetable wastes at Koyembedu market in 2004. It is the first ecofriendly power plant in India. The investment for this project is about Rs.50 million. The special feature of the process is the digestion of vegetable waste in Biogas Induced Mixed Arrangement (BIMA) digester. It will generate around 5 MW electricity and 10 tpd of biofertilizer.

Table 2. Comparison of Corporation of Chennai and Onyx Facilities and Services

Sl. No.	Infrastructure	CoC	ONYX
1.	Light and heavy Mechanical vehicles	160	250
2.	Tippers	251	-
3.	Autorickshaws	-	163
4.	Autotrailer	8	-
5.	Tricycles	1488	-
6.	Container bins	2000	4073
7.	Loose litter collector	-	1029
8.	Manpower	10000	2000
9.	Collection rate (tpd)	2000	1000
10.	Collection cost (USD/t)	33	25
11.	Number of Zones	7	3

7. INVOLVEMENT OF COMMUNITY BASED ORGANISATIONS

A few examples of the community based organizations involved in the MSWM of the city are presented in Table 3. Exnora International is a broad based voluntary NGO established in Adyar, Chennai in 1988. The objectives of Exnora include the creation of environmental awareness among citizens (www. Toxiclinks.org). Over the past decade and a half, Exnora has been able to motivate and form thousands of CBOs each comprises of 70-75 families. They took "Civic Pride" in their locality, managed their waste in an environment friendly way and in part were able to participate in the governance of their locality. The practices implemented by "Civic Exnora" are:

- Community motivation and encouragement of high level self-involvement.
- Incomes at the household level through recycling and reusing.
- Spreading the message and helping the communities to Zero Waste Management

8. IMPROVEMENTS TO OPEN DUMPS

CoC has already initiated the improvement projects in the open dumping ground as per the recommendations given by National Productivity Council (NPC, 2005) and Centre for Environmental Studies (CES), Anna University, Chennai (Figure.7). CES is carrying out a research project on "Sustainable Solid Waste Landfill Management in Asia" under the Asian Regional Research Programme on Environmental Technology. As part of the project, assessment of reclamation and hazard potential of the sites was carried out. Detailed investigations on solid waste characteristics, leachate quality and methane emission potential of the dumpsites were used to assess the reclamation potential. Landfill mining studies showed that the soil fraction of the mined waste from the dumpsites is 40 – 60%, which can be reclaimed as compost or cover material. The recovered space can be reused for future dumping. An integrated risk based approach was also developed for the rapid assessment of the hazard potential of the dumpsite. Validation of the approach indicates both sites have moderate hazard potential and need to be rehabilitated (Esakku, 2006).

Table 3. Various Community Based Organizations in Solid Waste Management

Organization	Approach
Civic Exnora	• 18 % of the MSW generated in Chennai is managed by Civic Exnora • Created about 1,500 jobs and Offers rag pickers rehabilitation
Mahalakshmi Road Welfare Association	• Each householder contributed Rs. 350 /- towards the association • Door to door collection of wastes • It has a Separate Composting plan.
Purna Nagar CBO	• Established in 1992 with 150 middle class households • Has 14 office bearers working towards the environmentally sound MSWM
Shanthi Nagar CBO	• Established in 1994 with 150 upper grade income households. • It aims to fill up the gaps in the conservancy services. • Income boost up by selling of recyclables. • The organization is managed by 12 committee members, a President, Secretary and Treasurer.
Kumari Nagar CBO	• 5 year old CBO run by housewives of the area. • Collects Rs. 200 /- as annual fee from its members (160 approx.) and uses it for cleaning purpose of 7 streets in the area.

Source: Srinivasan (2005)

The infrastructure created at the dumpsites:

- Construction of compound wall at Kodungaiyur landfill site
- WBM roads has been completed at both the sites
- Improvement of the Transfer station
- Construction of compost yards at various wards

Proposed infrastructure for the dumpsites:

- Phase-wise improvement of the dumpsites to sanitary landfills
- Construction of soil bund around the dumpsites to prevent sliding
- Construction of mechanical compost plant and leachate evaporation ponds
- Closure of sanitary landfill with top cover and gas venting system
- Mechanical composting and RDF plant for waste management

Leveling at Dumpsite

WatchTower

Compound Wall & Green Belt

Access Gate

Figure 7. Infrastructure Developed at Kodungaiyur Dumping Ground

9. CONCLUSION

The experience from Chennai in waste management shows that cost effective waste management is provided by the private sector. CoC has implemented the seven important mandatory requirements of the MSWM Rule (MoEF, 2000) in most part of the city. It has also initiated the upgradation steps to convert the open dumpsites to sanitary landfills. However, CoC requires addressing problems due to financial support, political issue, public support and lack of CBOs participation to provide a better MSWM for the city.

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