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Sustainable Decentralized Model For Solid Waste Management In Urban India

T. Subramani[1] R. Umarani[2] S. K. Bharathi Devi[3]
[1]Professor & Dean, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions University, Salem, India.
[2,"]PG Student of Environmental Engineering, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions University, Salem
[3]Pro term Lecturer, Department of Civil Engineering, VMKV Engineering College,Vinayaka Missions University, Salem

ABSTRACT
This paper attempts to assess the various factors that govern the sustenance of a decentralized Solid waste management system in urban India. Towards this end, two decentralized composting facilities (One operational and the other closed) were studied both of which were started at the same time in Bangalore. The parameters covered under the study were the technology and the technical expertise, Managerial influence, economic viability, community support including the socio- economic status of the Community and the influence of parallel government schemes. Our findings indicate that success and long-term.
KEYWORDS: Sustainable Decentralized Model, Solid Waste Management, Municipal Solid Waste.

I. INTRODUCTION

The continuous growth of population and rapid economic development in urban areas, many public, private and informal sector service providers in cities in developing countries are unable to cope with increasing volumes of solid waste, especially in poor and low-income areas. Regular and safe disposal of solid waste is the basis for hygiene and prevention of diseases and hence the foundation for any development activities oriented at poverty alleviation through improvement of health. Exploding populations and changing lifestyles are generating enormous amounts of waste. Studies have revealed that the quantum of waste generated varies between 0.2 - 0.4 kg/capita/day in urban cities and goes up to 0.5 kg/capita/day in metropolitan cites. Municipal agencies spend 5 - 25% of their budget on MSW management, which is Rs 75 - 250/capita/year. In spite of the various measures to treat waste the ULBs are currently unable to satisfactorily fulfill their general duties. This has resulted in health problems such as diarrhea, cholera and malaria among the masses. The quality of life has depleted and manpower has become less due to this increased disease frequency. Of the total MSW generated in India, 30 - 40% consists of organic waste, 30 - 40% ash and fine earth, 3 - 6% paper while a meager proportion of less than 1% accounts for plastics, glass and metals. The following table 1.1 shows the MSW generated per day in 6 major cities.

Table 1.1: MSW generated in 6 major cities

City corporation	*Population*	*Waste generated (tons/day)*	*Waste collected (tons /day)*	*Per capita waste generated (grams/day)*
Bangalore	5,882,162	2500	1400	425
Mangalore	5,51,701	250	200	453
Hubli/Dharwad	80,442	250	200	311
Mysore	794,677	230	183	289
Belgaum	516,155	120	100	232
Gulbarga	452,944	120	100	264
Total	8,999,081	3,470	2,183	386

1.1 Solid Waste Threatens Public Health Of Urban Areas

Wild dumping practices lead to direct and indirect spread of epidemics & diseases through waste accumulation in settlements (plague, malaria, dengue fever, typhus, cholera).Accumulation of waste in drainage networks and waterways increases risk of flooding and contamination of water resources.Burning of solid waste leads to increased air pollution and respiratory diseases.

1.2 Solid Waste Management- A Growing Challenge For Cities

- 760.000 tons of solid waste produced by urban households in 1999
- In 2025, it is estimated that 52% of the world‘s population live in cities and produce 1.8 million tons of solid waste per day.

- In many Asian cities only 30-80 % of total household waste is collected by private and public collection services.
- Private waste collection services mainly focus on medium and high-income residential areas, whose waste often contains a higher concentration of potentially valuable recyclables.
- Due to non-availability of collection services, residents of low-income areas increasingly bury, burn or dump their waste in remaining open spaces within settlements.
- Final disposal sites are not well managed.
- Widespread uneconomical disposal of solid waste

At present, in the municipality of Bangalore, the corporation lorries and staff carry the waste collected from the residents and bins to dumping areas. Private contractors selected by a tendering process to clear and take away the waste also supplement this effort. In several wards, door-to-door collection has been introduced with BMP employees playing a major role in collecting and transporting the wastes away from the residential areas.

One of the obvious advantages of a decentralized system is the improved aesthetic condition in the locality. Also it will not require a secondary collection service by the municipality. Decentralized schemes provide better income and employment options to the underprivileged sections of the society. The legal framework of the country, headed by the Honorable Supreme Court of India
has given support to community based waste management schemes through a national legislation – the Municipal Solid Waste (Management and Handling) rules, 2000 (Ministry of Environment and Forest, 2000).

One section of the rules requires the urban local bodies to promote and implement waste segregation at the source. The community can thus avail of legal backing for its decentralized initiative for municipal waste management. In light of this aspect a study was undertaken to ascertain the various parameters governing sustainability of a decentralized composting unit in urban India.

India is the second largest nation in the world, with a population of 1.21 billion, accounting for nearly 18% of world's human population, but it does not have enough resources or adequate systems in place to treat its solid wastes. Its urban population grew at a rate of 31.8% during the last decade to 377 million, which is greater than the entire population of US, the third largest country in the world according to population. India is facing a sharp contrast between its increasing urban population and available services and resources. The present citizens of India are living in times of unprecedented economic growth, rising aspirations, and rapidly changing lifestyles, which will raise the expectations on public health and quality of life. Remediation and recovery of misused resources will also be expected. These expectations when not met might result in a low quality of life for the citizens. Pollution of whether air, water or land results in long-term reduction of productivity leading to a deterioration of economic condition of a country. Therefore, controlling pollution to reduce risk of poor health, to protect the natural environment and to contribute to our quality of life is a key component of sustainable development. The per capita waste generation rate in India has increased from 0.44 kg/day in 2001 to 0.5 kg/day in 2011, fuelled by changing lifestyles and increased purchasing power of urban Indians. Urban population growth and increase in per capita waste generation have resulted in a 50% increase in the waste generated by Indian cities within only a decade since 2001.

Informal recycling system is lately receiving its due recognition world-wide for its role in waste management in developing nations. In India, government policy and non-governmental organizations (NGOs) are expected to organize the sector present in different regions, and to help integrating it into the overall formal system. 'Plastic Waste Management and Handling Rules, 2011' by the Ministry of Environment and Forests (MOEF) is a step ahead in this direction. These rules mandate ULBs to coordinate with all stake holders in solid waste management, which includes waste pickers.

India has a total of five RDF processing plants, located near Hyderabad, Vijayawada, Jaipur, Chandigarh and Rajkot. The first two plants burn the RDF produced in WTE boilers, whereas the next two burn the RDF in cement kilns. Details about the Rajkot facility are not available. All these facilities have encountered severe problems during operation. Problems were majorly due to lack of proper financial and logistical planning and not due to the technology.

Only two WTE combustion plants were built in India, both in New Delhi. The latest one among them has finished construction in Okhla landfill site and is about to begin operations. It is designed to generate 16 MW of electricity by combusting 1350 TPD of MSW.

II. NEED FOR WASTE MANAGEMENT

Management of Solid Waste (MSW) is a serious challenge being faced by the urban and rural communities all over the world. It has acquired grave proportions in urban areas, particularly in the large urban settlements. According to various estimates, about 48 million tonnes of municipal solid waste is currently being generated every year in India, which

is likely to grow two-folds in another 15 years or so. It may also be noted that the quantity and physical composition of solid waste is continuously changing with population redistribution, changing lifestyles, income, and consumption patterns in Indian towns and cities.

2.1 SCOPE OF DECENTRALIZATION

This report focuses on various options available for the disposal of municipal solid waste (MSW) sustainably and attempts to provide a documented picture of their suitability to India. The report is divided into two parts, Part I and Part II. The first part will explain the present solid waste management (SWM) crisis in India, its impacts on public health, environment and quality of life and touch upon efforts towards SWM in the past. The second part deals with the Earth Engineering Center's initiative, WTERT – India to help improve SWM in India and presents some articles viewership statistics of the internet blog (www.swmindia.blogspot.com) based upon this research.

The first part introduces the Hierarchy of Sustainable Waste Management as shown in figure 2.1, which will act as the framework for the rest of this report.

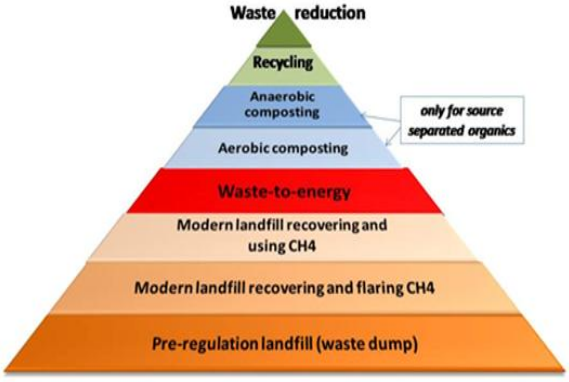


Figure 2.1

Scope of the Study: Boxes Indicate the Methods of Waste Disposal Studied in Comparison to the Hierarchy of Sustainable Waste

III. MUNICIPAL SOLID WASTE (MSW)

Waste is defined as any material that is not useful and does not represent any economic value to its owner, the owner being the waste generator (10). Depending on the physical state of waste, wastes are categorized into solid, liquid and gaseous. Solid Wastes are categorized into municipal wastes, hazardous wastes, medical wastes and radioactive wastes. Managing solid waste generally involves planning, financing. Construction and operation of facilities for the collection, transportation, recycling and final disposition of the waste (10). This study focuses only on the disposal of municipal solid waste (MSW). The following table 3.1 shows Sources and Types of Municipal Solid Waste.

Table.3.1: Sources and Types of Municipal Solid Waste

Sources	Typical waste generators	Components of solid waste
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, glass, metals, ashes, special wastes (bulky items, consumer electronics, batteries, oil, tires) and household hazardous wastes
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, government center, hospitals, prisons	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Municipal services	Street cleaning, landscaping, parks, beaches, recreational areas	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational areas

3.1 Composition Of Urban Msw In India

A major fraction of urban MSW in India is organic matter (51%). Recyclables are 17.5 % of the MSW and the rest 31% is inert waste. The average calorific value of urban MSW is 7.3 MJ/kg (1,751 Kcal/kg) and the average moisture content is 47%. It has to be understood that this composition is at the dump and not the composition of the waste generated. The actual percentage of recyclables discarded as waste in India is unknown due to informal picking of waste which is generally not accounted. Accounting wastes collected informally will change the composition of MSW considerably.

3.2.Decentralisation Steps And Process

1. Situational Analysis through base line survey
2. Rapport Building, raising awareness amongst the residents, Self Help Group members and waste collectors to prepare them to anticipate in the community based solid waste management programme.
3. Training and Capacity building of waste collectors.
4. Regular Monitoring of the programme
5. Community Based Composting through Effective Micro- organism (EM)

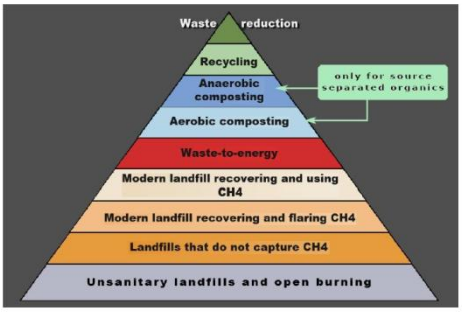
Segregated Bio Degradable (wet waste) in compost pits as shown in figure 3.1.

Figure 3.1

The Hierarchy of Sustainable Waste Management developed by the Earth Engineering Center at Columbia University is widely used as a reference to sustainable solid waste management and disposal. This report is presented in reference to this hierarchy. For the specific purpose of this study, "Unsanitary Landfilling and Open Burning" has been added to the original hierarchy of waste management which ends with sanitary landfills (SLFs).

The hierarchy of waste management recognizes that reducing the use of materials and reusing them to be the most environmental friendly. Source reduction begins with reducing the amount of waste generated and reusing materials to prevent them from entering the waste stream. Thus, waste is not generated until the end of "reuse" phase. Once the waste is generated, it needs to be collected. The Hierarchy of Sustainable Waste Management as shown in figure 3.2.

Figure 3.2



3.4 Recycling

Reducing and reusing are the most effective ways to prevent generation of wastes. Once the wastes are generated and collected, the best alternative to handle them would be recycling where the materials generally undergo a chemical transformation. Sometimes, reusing can also happen after collection, in cases where informal traders collect materials of no use from households, reshape or repair them and sell in second-hand markets. Unlike reusing a used material, recycling involves using the waste as raw material to make new products. Recycling thus offsets the use of virgin raw materials.

3.5 Waste-To-Energy Combustion (WTE)

Waste-to-Energy combustion (WTE) is defined as a process of controlled combustion, using an enclosed device to thermally breakdown combustible solid waste to an ash residue that contains little or no combustible material and that produces, electricity, steam or other energy as a result. Even though both WTE combustion and RDF combust MSW, the objective of WTE combustion is treating MSW to reduce its volume. Generating energy and electricity only adds value to this process.

3.6 Sanitary Landfilling

United Nations Environmental Program (UNEP) defines sanitary landfilling as the controlled disposal of wastes on land in such a way that contact between waste and the environment is significantly reduced and wastes are concentrated in a well defined area. a)Compaction of the wastes, b) Daily covering of wastes

3.7 Composting or Mechanical Biological Treatment:

On an average, 6% of MSW collected is composted in mechanical biological treatment (MBT) plants across India. MBT is the most widely employed technology to handle MSW in India. Currently, there are more than 70 composting plants in India treating mixed MSW, most of them located in the states of Maharashtra, Himachal Pradesh, Chhattisgarh and Orissa

3.8 REFUSE DERIVED FUEL (RDF):

There are 6 RDF plants in India, near Hyderabad, Vijayawada, Jaipur, Chandigarh, Mumbai and Rajkot. The plant in Vijayawada used to serve the city of Guntur too. The Hyderabad and Vijayawada plants handled 700 TPD and 500 TPD of MSW to generate 6 MW of electricity respectively. RDF produced in these plants was combusted in specifically designed WTE boilers. The author visited one of these plants and found out that both these facilities are currently not in operation.

The RDF plants near Jaipur and Chandigarh combust the RDF produced in cement kilns to replace fossil fuels. They handle 500 TPD of MSW each.. Using water polluted by solid waste for bathing, food irrigation, and as drinking water can also expose individuals to disease organisms and other contaminants. The city Surat has experienced a city-wide bubonic plague epidemic in 1994 due to improper SWM. Open burning of MSW on streets and at landfills, along with landfill fires emit 22,000 tons of pollutants into

the lower atmosphere of Mumbai city, every year..

3.9 Improper Solid Waste Management (Waste Disposal)

Improper solid waste management deteriorates public health, degrades quality of life, and pollutes local air, water and land resources. It also causes global warming and climate change and impacts the entire planet. Improper waste management is also identified as a cause of 22 human diseases and results in numerous premature deaths every year. Indiscriminate dumping of wastes and leachate from landfills contaminates surface and groundwater supplies and the surrounding land resources. It also clogs sewers and drains and leads to floods. Using water polluted by solid waste for bathing, food irrigation, and as drinking water can also expose individuals to disease organisms and other contaminants. The city Surat has experienced a city-wide bubonic plague epidemic in 1994 due to improper SWM. Open burning of MSW on streets and at landfills, along with landfill fires emit 22,000 tons of pollutants into the lower atmosphere of Mumbai city, every year.

3.10 Open Burning, Landfill Fires & Air Quality Deterioration

Open burning is the burning of any matter in such a manner that products of combustion resulting from the burning are emitted directly into the ambient (surrounding outside) air without passing through an adequate stack, duct or chimney. Open burning of wastes is practiced all over India due to reasons like

a) Open burning by waste-pickers for recovery of metals from mixed wastes;

b) Open burning in bins by municipal workers or residents to empty MSW collection bins;

c) Open burning of plastic wastes by street dwellers for warmth at night.

IV. DECENTRALISED COMPOSTING MODEL

4.1 Estimated generation of waste

Total population of the society: 7,500

Average per capita per day waste generation: 200 gram

Average per capita per day wet waste generation: 100 gram

Total wet waste generation from 7,500 population is 750 Kg per day

Monthly wet waste generation from 7,500 populations would be 22,500 Kg.

4.2 About Em (Effective Micro-Organism

EM is a liquid concentrate (brownish liquid suspension made by collecting and growing natural microorganisms. The microorganisms are chiefly Lactobacillus, photosynthetic bacteria, yeast and filamentous fungi.

The technology was developed at the University of Ryukus, Okinawa, Japan by a distinguished professor of horticulture, Dr.Teruo Higa. • The uniqueness of EM stems from the fact that what humans consider contaminated and offensive is food for microorganisms.

V. PREPARATION OF EM SOLUTION FOR COMPOSTING

5.1 Equipments required for preparing Extended Solution

1. Two barrels of 125 Liters. Capacity with tight lids.
2. One L EM Bottle
3. 2 Kg. Jaggery
4. 100 L Water

5.2 Steps for preparing the extended EM solution:

1. Mix the jaggery and the water well.
2. Add the EM Solution (Whole Bottle)
3. Cover it with the lid tightly.
4. On third and 5th day, stir it properly to release the gas and cover it again.
5. The solution is ready for use on the 7th day.

5.3 Composting Process Steps

- Put the garbage into the ready pit
- Sprinkle the prepared EM solution to the garbage (@ 1 L Extended. Solution / 200 Kg garbage)
- Mix 1 L Solution +10 L Water in a bucket.
- Add water just enough to make it moist. (May be run the pipe for 3 mins). Watering should be done evenly all across the garbage in the pit . Then cover it with the jute sheet
- The garbage should be turned every two days (minimum. thrice a week)
- EM solution and the watering should be strictly done daily. (This is important to avoid offensive smell and flies and mosquitoes)

VI. SUSTAINABLE WASTE MANAGEMENT

Comparison of SWM in India with the hierarchy of sustainable waste management does not show a very bright situation. It indicates a developing country with a huge population and growing economy and scattered but ongoing efforts towards SWM. There is also a definite awareness among local bodies as well as policy

makers on SWM. Changes expected in disposal of MSW in the near future are

a. more extensive integration of informal waste sector into the formal systems,
b. further increase in the construction of composting facilities,

VII. CONCLUSIONS

Two decades of economic growth since 1990 has changed the composition of Indian wastes. The quantity of MSW generated in India is increasing rapidly due to increasing population and change in lifestyles. Land is scarce and public health and environmental resources are precious. The current SWM crisis in India should be approached holistically; while planning for long term solutions, focus on the solving the present problems should be maintained.

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