# SOLID WASTE MANAGEMENT

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**Study materials for Semester IV**

**ARTICULATED BY Dr. ABHIK DASGUPTA**
**ASSISTANT PROFESSOR**

## SOLID WASTE MANAGEMENT IN INDIA OR DEVELOPING COUNTRY PERSPECTIVE

Municipal solid waste management in developing countries has given alarming signals because of their improper waste management. The urbanization, industrialization, and an increase in economic status and activities have increased the quantity of municipal solid waste and altered its contents. Although the developing countries generate less solid waste per capita in comparison to developed countries, the collection, storage, transportation, processing and disposal of solid waste is highly ineffective, and consequently damaging to the environment. A poor understanding of solid waste management leads to different kinds of environmental problems within urban metropolises.

In India municipal solid waste management is unscientific and chaotic. Uncontrolled dumping of wastes on dumping yards in towns and cities has created overflowing landfills. There are also serious environmental implications in terms of ground water pollution. The mismanagement of waste is a cause for diseases like cholera, dysentery, jaundice, typhoid and diarrhoea. Therefore, MSWM is one of the major environmental problems of Indian cities. It involves activities associated with generation, storage, collection, transfer and transport, processing and disposal of solid waste.

The average MSW generation in India is approximately 100,000 MT/day. Out of that, only 60-65 percent (60,000-65,000 MT/day) is collected by municipal corporations and councils. The rest is dispersed of in an unscientific manner. However, lifestyle changes, especially in the larger cities, are leading to the use of more packaging material and per capita waste generation is increasing by about 1.3 percent per year. With the urban population growing at 2.7 percent to 3.5 percent per annum, the yearly increase in the overall quantity of solid waste in the cities will be more than 5 percent. The Energy and Resources Institute (TERI) has estimated that waste generation will exceed 260 million tons per year by 2047-more than five times the present level.

Cities with 100,000 plus population contribute 72.5 percent of the waste generated in the country (Table 1.) as compared to other 3955 urban centers that produce only 17.5 percent of the total waste (Asnani, 2006) [3] . The management of MSW requires proper infrastructure, maintenance and upgrade for all activities. This becomes extremely expensive and complex due to the continuous and unplanned growth of urban centers.

**Table 1:** Waste Generation in Class I Cities with Population above 1, 00, 000

| Type of Cities | Population | Tones/day | Percent of Total garbage |
|---|---|---|---|
| The 7 Mega Cities | >4 million | 21, 100 | 18.35 |
| The 28 Metro Cities | 1-4 million | 16, 643 | 17.08 |
| The 388 Class I towns | 0.1-1 million | 42, 635 | 37.07 |
| **Total** | | **83, 378** | **72.50** |

**Note:** Mega cities are above 4 million population and metro cities are the same as the identified cities under the census of India. Class I cities with population in the 1, 00, 000 to 1 million ranges are 388 in number.
***Source***: TERI (2005)

(Copied from**:** Solid waste management in Indian cities: Issues and challenges by Vikas, Govt. College Gharaunda)

## A) Waste Generation in India

The increasing population, urbanization and changing lifestyles, the Indian cities now generate eight times more waste than they did in 1947. The amount of waste generated per capita is estimated to increase at a rate of 1 percent to 1.33 percent annually (Sharholy et al, 2008) [11] . The quantum of waste generation varies between 0.2-0.4 kg/capita/day in International Journal of Advanced Educational Research 243 urban centres and it goes up top 0.5 kg/capita/day in metropolitan cities. The urban population has increased from 17.6 percent to 28 percent in the last 50 years and is expected to rise to 38 percent by the year 2020. The increased MSW generation can be ascribed to our changes in living standards. Per capita waste generation ranges between 0.2 kg and 0.6 kg per day in the Indian cities amounting to about 1.15 lakh MT of waste per day and 42 million MT annually. As the city expends, the per capita waste generation is also increases.

## B) Waste Management: Indian Perspective

The composition and the quantity of MSW generated from the basis on which the management system needs to be planned, designed and operated. The composition of MSW at generation sources and collection points was determined on a wet weight basis and it consists mainly of a large organic fraction (40-60%), ash and fine earth (30-40%), paper (3-6%), and plastic glass and metals (each less than 1%). . . Unfortunately, no city in India can claim 100% segregation of waste at dwelling unit and on an average only 70% waste collection is observed, while the remaining 30% is again mixed up and lost in the urban environment. Out of total waste collected, only 12.45% waste is scientifically processed and rest is disposed in open dumps (CPCB Report, 2013).

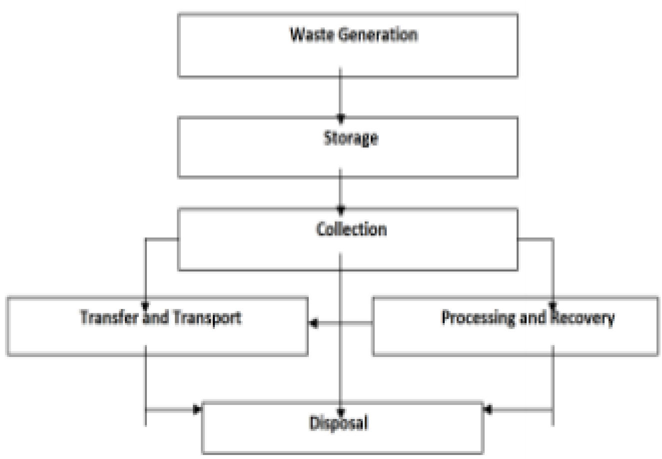


**Fig 1:** Interrelationship between the Functional Elements in Solid Waste Management

**On-site disposal options**:

On-site disposal includes two steps:

1) Collection of Waste

2) Transportation of Waste

## 1) Collection of Waste:

Collection of wastes has been done from the following points:

The technology choices outlined below are general guidelines for disposal and storage of waste on-site, these may be adapted for the particular site and situation in question.

i. **Communal pit disposal**: Perhaps the simplest solid waste management system is where consumers dispose of waste directly into a communal pit. The size of this pit will depend on the number of people it serves.

**ii.** **Family pit disposal:** Family pits may provide a better long-term option where there is adequate space. This method is best suited where families have large plots and where organic food wastes are the main component of domestic refuse.

**iii.** **Communal bins:** Communal bins or containers are designed to collect waste where it will not be dispersed by wind or animals, and where it can easily be removed for transportation and disposal. A popular solution is to provide oil drums cut in half. The bases of these should be perforated to allow liquid to pass out and to prevent their use for other purposes. A lid and handles can be provided if necessary.

**iv.** **Family bins:** Family bins are rarely used in emergency situations since they require an intensive collection and transportation system and the number of containers or bins required is likely to be huge.

**v.** **Communal disposal without bins:** For some public institutions, such as markets or distribution centers, solid waste management systems without bins can be implemented, whereby users dispose of waste directly onto the ground.

## 2. Transportation of Waste

Where bins or collection containers require emptying, transportation to the final disposal point is required. As described, waste transportation methods may be human-powered, animal-powered or motorised.

i) **Human-powered**: Wheelbarrows are ideal for the transportation of waste around small sites such as markets but are rarely appropriate where waste must be transported considerable distances off-site.Handcarts provide a better solution for longer distances since these can carry significantly more waste and can be pushed by more than one person.

ii) **Animal-powered**: Animal-powered transportation means such as a horse or donkey with cart are likely to be appropriate where they are commonly used locally.

iii) **Motorised:** Where the distance to the final disposal site is great, or where the volume of waste to be transported is high, the use of a motorised vehicle may be the only appropriate option. For large volumes of waste it may sometimes be appropriate to have a two-stage transportation system requiring a transfer station.

**Table 5:** Transport Capacity to Carry Municipal Solid Waste

| Capacity (cubic meters/ million population) | Cities (%) 44 cities |
|---|---|
| <100 | 4.5 |
| 100-200 | 34.1 |
| 200-300 | 29.6 |
| 300-400 | 25.0 |
| >400 | 6.8 |

## (A) Off-site disposal options:

The technology choices outlined below are general options for the final disposal of waste offsite.

### 1) Sanitary landfills

Landfills are designed to greatly reduce or eliminate the risks that waste disposal may pose to the public health and environmental quality. They are usually placed in areas where land features act as natural buffers between the landfill and the environment. Some sanitary landfills are used to recover energy. The natural anaerobic decomposition of the waste in the landfill produces landfill gases which include Carbon Dioxide, methane and traces of other gases. Methane can be used as an energy source to produce heat or electricity. Thus some landfills are fitted with landfill gas collection (LFG) systems to capitalize on the methane being produced. The process of generating gas is very slow, for the energy recovery system to be successful there needs to be large volumes of wastes. These landfills present the least environmental and health risk and the records kept can be a good source of information for future use in waste management, however, 10 the cost of establishing these sanitary landfills are high when compared to the other land disposal methods.

i) **Controlled dumps**: Controlled dumps are disposal sites which comply with most of the requirements for a sanitary landfill but usually have one deficiency. They may have a planned capacity but no cell planning, there may be partial leachate management, partial or no gas management, regular cover, compaction in some cases, basic record keeping and they are fenced or enclosed.

ii) **Bioreactor Landfills**: Recent technological advances have lead to the introduction of the Bioreactor Landfill. The Bioreactor landfills use enhanced microbiological processes to accelerate the decomposition of waste. The main controlling factor is the constant addition of liquid to maintain optimum moisture for microbial digestion. This liquid is usually added by re- circulating the landfill leachate. In cases where leachate in not enough, water or other liquid waste such as sewage sludge can be used. The landfill may use either anaerobic or aerobic microbial digestion or it may be designed to combine the two. These enhanced microbial processes have the advantage of rapidly reducing the volume of the waste creating more space for additional waste, they also maximise the production and capture of methane for energy recovery systems and they reduce the costs associated with leachate management. For Bioreactor landfills to be successful the waste should be comprised predominantly of organic matter and should be produced in large volumes.

## 2) Thermal Treatment:

This refers to processes that involve the use of heat to treat waste. Listed below are descriptions of some commonly utilized thermal treatment processes.

i) **Incineration**: Incineration is the most common thermal treatment process. This is the combustion of waste in the presence of oxygen. After incineration, the wastes are converted to carbon dioxide, water vapour and ash. This method may be used as a means of recovering energy to be used in heating or the supply of electricity

ii) **Pyrolysis and Gasification:** Pyrolysis and gasification are similar processes they both decompose organic waste by exposing it to high temperatures and low amounts of oxygen. Gasification uses a low oxygen environment while pyrolysis allows no oxygen. These techniques use heat and an oxygen starved environment to convert biomass into 11 other forms. Gasification is advantageous since it allows for the incineration of waste with energy recovery and without the air pollution that is characteristic of other incineration methods.

iii) **Open burning:** Open burning has been practiced by a number of urban centres because it reduces the volume of refuse received at the dump and therefore extends the life of their dumpsite. Garbage may be burnt because of the ease and convenience of the method or because of the cheapness of the method.

## 3) Biological Waste Treatment

i) **Composting**: Composting is the controlled aerobic decomposition of organic matter by the action of micro organisms and small invertebrates. There are a number of composting techniques being used today. These include: in vessel composting, windrow composting, vermin composting and static pile composting. The process is controlled by making the environmental conditions optimum for the waste decomposers to thrive. The rate of compost formation is controlled by the composition and constituents of the materials i.e. their Carbon/Nitrogen (C/N) ratio, the temperature, the moisture content and the amount of air.

ii) **Anaerobic Digestion:** Anaerobic digestion like composting uses biological processes to decompose organic waste. However, where composting can use a variety of microbes and must have air, anaerobic digestion uses bacteria and an oxygen free environment to decompose the waste. Aerobic respiration, typical of composting, results in the formation of carbon dioxide and water. While the anaerobic respiration results in the formation of carbon dioxide and methane. In addition to generating the humus which is used as a soil enhancer, anaerobic digestion is also used as a method of producing biogas which can be used to generate electricity

**Table: 6:** Relative Capital Cost of MSWM Technological Comparison

| Technology | MSW Quantity (T) | Land Required (Acers) | Cost (cr.) |
|---|---|---|---|
| Biomenthanation | 150 | 6-7 | 6-7 |
| Incineration | 100 | 2-3 | 6-7 |
| Composting | 150 | 7-8 | 1.5-2 |

***Source:*** The World Bank Report (Improving management of municipal solid in India overview and challenges)

## 4) Resource Recovery and Reuse:

This is where solid waste is not put to direct disposal but the recyclable or reusable materials are sought out, cleaned, or re-processed and used for the original or for other purposes. This approach is highly acceptable to the public as it reduces waste of resources. It can also act as a source of income from the sale of salvaged metals, plastics, and glass as well as recovered energy (Ndoria, 2005).

This approach extends the life of the available open dumps and landfill sites. High initial and operational costs are however involved. A market must also be sought for the recovered materials and the energy produced. Costly maintenance and repairs are also involved and skilled operators are required (Miller, 1986). Resource recovery can have two approaches:

i) **High Technology Approach:** This is where large centralized resource recovery plant shreds and automatically separates mixed urban waste to recover glass, iron, aluminium, and other valuable materials, which are sold to manufacturing industries for recycling. The remaining paper, plastics, and other combustible wastes can be incinerated to produce steam, hot water or electricity. The incinerator residue including particulates removed to prevent air pollution can be used to reclaim damaged land as landfill sites or can be processed into blocks, bricks and other building materials (Miller, 1986).

ii) **Low Technology Approach**: This involves source separation i.e households and businesses place their waste material such as glass, paper, metals, and food scraps into separate containers. Compartmentalized city collection trucks, private haulers, or voluntary recycling organizations pick up the segregated waste, clean them if necessary and sell them to scrap dealers, composting plants or manufacturers.

## Conclusion:

The use and promotion of appropriate waste disposal techniques have become necessary to achieve a much healthier and cleaner environment in the world especially in the developing counties. For effectiveness,

1. The governments and concerned agencies of these countries will do well to take the lead by encouraging the production and/or introduction of appropriates technology, equipment/machines including waste disposal vehicles for sound waste management procedures. The equipment should include machines capable of producing recyclable materials and machines that could recycle used materials to reusable ones.

2. Waste paper bags, dustbins, trashcans and disposal drums should be provided in strategic locations in the public and private places. Households should be knowing what materials are readily biodegraded and which substance are not; each of which should be disposed in different drums.

3. Collection by waste disposal vehicles should then follow promptly. These will then be transported and disposal of in the appropriate places for proper storage, treatment and/or 13 recycling.

4. Adequate information and training should be given and disseminated to all concerned information pertaining to the negative impacts of wastes on and in the environment, waste disposal techniques, new technologies and their applications, could be communication through congresses, seminar, workshops, lectures, TV and Radio enlightenment programmes. This form of training and education is of outmost importance for all in the urban and rural communities. The training should include instructions on how to keep the surrounding clean by making proper use of the trashcans provided and not by throwing dirt and waste polythene on the bare ground/ floor indiscriminately.

5. Good environment management (Aina, 1991), as well as sound waste disposal techniques aims at reducing and avoiding pollution, erosion and resource wastage.