# Waste Minimization

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**ABSTRACT**

***Solid waste generation is increasing problem at global and local level. Improper disposal of waste pollutes all the components of environment. There has been a significant increase in waste generation due to rapid population growth and economic development. There are mainly four functional elements of waste management that is storage and collection, transportation, treatment and disposal of waste. In order to minimize the waste these elements should be optimized. This paper includes a brief discussion on waste management situation of different parts of the world and drawbacks of waste management. Based on the studies it was found that in most of the places mixed waste is generated which is difficult to handle. Geographical information system can be used as an effective tool for proper allocation of waste bins and also separated bins needs to be provided for biodegradable, recyclable, non-biodegradable waste. In place of conventional system for collection, door to door collection system should be implemented as primary method. Transportation system should be improved and some transfer station needs to be established considering standard parameter to save fuel and man power requirement. Processing and treatment of waste is the most neglected area of waste minimization process. We found that physical and chemical characteristics of waste plays an important role to suggest the suitable treatment option for waste minimization and waste can be used as a potential source of biogas and power generation This paper tells that unscientific disposal of waste is affecting soil and ground water quality. Most of the work published in this field is reviewed and concluded that a potential landfill site can be selected on the basis of certain environmental and economic parameter using sensitivity site index method. Therefore the present review aims to help environmental managers and decision-makers to find possible solutions for disposal and processing of waste***

***Keywords: Municipal Solid Waste (MSW), Heavy Metals, Literature review, Waste management, Delphi technique, Bio gas, Power generation, and geographical information system (GIS)***

## 1. INTRODUCTION

The activities of human produces waste and the ways in that waste is handled, stored, collected, and disposed of can create problems to the environment and to public health. Solid waste

management (SWM) includes all activities that reduce health, environmental, and aesthetic impacts of solid waste. In the urban areas of most of the developing cities solid waste management has become a very serious problem. Municipal authorities understand the importance of solid waste management but due to rapid growth of population there sources became scarce.

According to a survey conducted by United Nations Development Program on 151 mayors of cities, the most serious problem after unemployment that people are facing is improper solid waste management. Only 40% of total waste is collected rest of the 60% waste is dumped directly in streets and drains which results in chocking of drains, growth of flies and rodents, flooding and spreading disease. The waste that is collected is directly disposed to unscientific open dump site. The leachate produced from these sites pollutes ground water quality. Greenhouse gases mainly methane and carbon di oxide also emitted from these landfill sites which causes global warming. **Visvanathan et.al.** Carried out a study in 2001 shows that disposal of waste is a serious problem in Asia due to unorganized and uncontrolled urban growth. Also there is lack of money and trained men power for SWM system. According to them, the waste generated per capita in Asia is around 0.2kg/day to 1.7kg/day**,** Solid waste is being disposed in open dumping sites in most of the Indian cities which poses a risk for environment **(Mufeed, 2006).** .Like other Bangladesh is another country which is facing the problems in managing solid waste. The collection efficiency is less than 50%. There is lack of waste bins and also bins are not allocated properly on roadsides. So waste is scattered here and there, results in flooding, dirty streets, blocking of drains.

As early as 50 years ago, Wolman (1969) presented a **"City Metabolism"** model in which he emphasized on the importance of proper waste management of a city. He told that "The metabolic cycle is incomplete until the wastes have been removed and disposed of with a minimum nuisance and hazard" Solid Waste Management (SWM) is a function of combination of various activities such as collection, transportation and disposal of solid waste. It also includes processing and treatment of the solid waste before disposing. **(Robinson, 1986)** The purpose of SWM is to create uncontaminated environment for people without disturbing natural resources **(World resource Foundation, 1996; McDougall et al., 2001)** and a proper SWM helps safe disposal, reduction of final waste and increase reuse and recycling. On the other hand a poor management system, on the contrary, leads to a filthy environment affecting the well-being of the people residing therein. Waste collection, shipment and disposal methods may change from place to place over the world. SWM system has been made better all over the world with the involvement of advanced technologies in well-established countries. For instance, In Australia a bin is provided to urban household to keep their waste in it and after it these bins are emptied by the local body **(ISWA, unep 2002)** in Netherland people has to charge a high tax on landfilling according to government policies. The purpose is to reduce the amount of waste to be landfilled. Incineration is the most

supported method here for waste treatment in order to reduce environmental pollution **(Bartelings, 2003).** People of Thailand are educated to segregate the waste at the point of generation itself. So wastes are segregated into 3 categories: recyclable, toxic and food waste, each type of waste is disposed in different bins **(Bui Van Ga, 2004)** Recycling and reuse of waste is very much in practice in Vietnam **(Vietnam Environment Monitor, 2004).** The municipal waste disposal and collection methods are made better in Vietnam, but there is no harmless disposed method.

## 2. QUANTITATIVE & QUALITATIVE ANALYSIS OF MUNICIPAL SOLID WASTE

MSW can be categorized as food waste, yards waste, rubbish, institutional waste, street sweeping waste, commercial waste industrial waste, construction and demolition waste, and sanitation waste. MSW contains recyclables waste (paper, plastic, glass, metals, etc.), hazardous substances (paints, pesticides, used batteries, medicines), organic matter that can be composted (fruit and vegetable peels, food waste) and soiled waste (blood stained cotton, sanitary napkins, syringes) **(Jha et al., 2003; Reddy and Galab, 1998 ;).** The range of per person waste generation in Indian cities is between 0.2 kg and 0.6 kg per day .The total amount of waste is 1.15 lakh per day and 42 million annually. Also, as the cities are expanding, average per capita waste generation is increasing.

**Rate of Waste Generation per person in Indian cities.**

| Range of Population (in million) | Waste generation (in million) gms/ person/ day |
|---|---|
| 0.1-0.5 | 210 |
| 0.5-1.0 | 250 |
| 1.0-2.0 | 270 |
| 2.0-5.0 | 350 |
| >5.0 | 500 |

***Source: NEERI (1995)***

The urban population is growing at 2.7 percent to 3.5 per cent per annum, so the yearly increase in the overall quantity of solid waste in the cities will be more than 5 per cent. 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.

## 3. SHORTCOMINGS IN PRESENT SOLID WASTE MANAGEMENT SERVICES

### *3.1 Waste is not segregated and stored at the source*

The waste is not separated at the point of generation that is why mixed waste is there, which is difficult to handle. Citizens have not been taught to keep the separate bins for different type of waste such as domestic, recyclable and inert waste, so they are throwing mixed waste on streets only.

### *3.2 No System for door to door collection as primary method*

In most of the cities, communal bin and street weeping are the primary method for collection and door to door collection system is implemented. Street Sweeping is not regular it is not being done on Sundays or public holidays. The number of sweepers allotted to a particular area of a city is also irregular. In some wards of a city there is excess of sweepers whereas in other areas of city there is shortage of sweepers.

Even sweepers are not performing their duties. Generally commercial road, main markets, important streets are prioritized and rest of the streets are swept occasionally or not swept at all. The tools used for street sweeping are generally inefficient and outdated. Conventional handcarts, wheel barrow, tricycles are used for collection of waste, which do not harmonize with the secondary storage systems. Waste disposed on the ground required multiple handling. Work is not distributed properly among sanitation workers, some have very less work to do while others are overburdened.

The places where communal bin are used, the bins are not sufficient in numbers and they are not allocated properly. In order to improve the collection system proper allocation of waste bins is required by considering population density, area and convenient distance from user. **(Syed, 2006), R. Nithya, A. Velumani et.al** suggested proper number and location of waste bins in one of the ward of Coimbatore by using GIS. His model was based on public preferable walking distance for deposing of waste into collection bin

### *3.3 Lacking of transfer stations for waste storage*

Conventional handcarts, wheel barrow, tricycles can collect only a small quantity of waste at a time so it is required to build transfer stations in scientific manner for temporary storage of waste before disposal so that number of trip required for transportation of waste to the distant disposal site can be reduced. But in practice, most of the cities are using open sites or round cement concrete bins for temporary storage of waste that requires multiple handling of waste. Waste spills over which is not hygienic as well as unsightly too.

### *3.4 Transportation of Waste*

Waste is transported from transfer station to the landfill site by different type of vehicles such as Dumper placer, tractors, bullock carts etc. Most of the vehicles are aged and not covered so spreading of waste pollute environment. In most of the places loading is done manually. A very few cities are using modern hydraulic vehicles as well. The conventional transportation system does not harmonized with the primary collection system and facilities of secondary waste storage which results in multiple manual handling of waste.

### *3.5 Treatment of Waste*

In most of the developing countries municipal solid waste is not being processed and all the waste is dumped directly into unscientific landfill sites or open sites which reduces the age of landfill site. In some cities composting, Bio gas and RDF plants are established for the resource generation from waste. **Amul Late and M. B. Mule et.al (2012)** carried out a study on characterization and composition of solid waste from Aurangabad city .The physical and chemical characteristics help in identification of energy recovery potential of waste and also in preparing waste management and disposal plan. Based on the results it was concluded that moisture content, PH and elemental percentage are in Moderate range so composting can be a good option for waste generated in Aurangabad city.

### *3.6 Disposal of Waste*

Disposal of waste is becoming difficult due to rapid Urbanization and Industrialization in cities. Most of the municipal authorities are disposing waste in unscientific manner in open dumping ground in the outskirts of the city. It produces bad smells, and also it allows flies, rodents to grow which causes diseases. The leachate generated in these sites pollutes ground water quality and poses serious risk to health. **Abhishek Gautam et.al. (2011)** assessed the Ground Water Quality at Municipal Solid Waste Dumping Site- Sewapura, Jaipur. He found that huge amount of solid waste generated from the residences, hospitals etc. is dumped in open land areas of Sewapura. Such dumping causes environmental pollution by deteriorating the ground water quality. The study on Physical–Chemical parameters of water samples revealed that high amount of Fluoride (2.4 - 3.2 mg/l), Chlorides (288.4 – 1038.2 mg/l) and TDS (610.4 – 1828.4 mg/l) are present in the samples which are of higher range than acceptable limits. The ground water in the study area is being polluted by percolation of toxic substances into it that may make it completely unfit for the purpose of drinking and irrigation. **Anirudh Sahni et.al. (2011)** assessed the heavy metal toxicity in soils nearby Municipal Solid Waste dumping site, Mathuradaspura – Jaipur. After evaluation the order of concentration of heavy metals found in soil was Fe> Zn > Cr > Ni > Cu > Pb > Cd. It can be concluded that the heavy metals in the soil are due to the MSW being dumped in the area. Slow leaching of heavy metals from MSW may be the reason for Soil Contamination. In order to rectify these problems, it is found necessary to select a landfill site which does not pose risk to environment .Delphi's risk index method is an effective tool for hazardous landfill site selection **(Delbecq *et al*., 1975). P. Pandiyan et.al (2011)** used Delphi's approach to assess the hazardous potential risk of three landfill sites of Tamilnadu. He considered following parameters to rank the landfill sites;

- Accessibility related
- Receptor related

- Ecological related
- Sociological related
- Waste management practice related
- Climatologically related
- Geological related

These parameters are given weightage according to their relative importance and then risk index was calculated. The landfill site with the lowest value of risk index was selected as best suitable site. 80% percent of the total waste is being disposed in the unscientific dumpsites which produce greenhouse gases like methane and carbon-di-oxide. TERI estimated that in 1997 about 7 million tons of methane is released in India into the atmosphere. This will increase up to 39 million ton in 2047, if amount of waste disposed to the landfill is not reduced by using waste treatment options like recycling, composting, power generation from waste etc. **Ashutosh Kumar, M.P. Sharma (2014)** estimated the greenhouse gas (GHG) emission from three landfill sites of Delhi by using a software LANDGEM version 3.02. The input data required for this software were composition of waste, waste quantity, life of landfill in years, elemental percentage of waste etc. Then other methods to estimate GHG like FOD and ICM were compared with LANDGEM and LANDGEM was declared the best method. They also describe the power generation potential from these landfill sites. The dynamic cost analysis has revealed that these landfill sites have an economically feasible potential of 3, 2 and 1.5 MW of electricity. **Ityona Amber, Daniel M Kulla et.al. (2012)** told that it was difficult to calculate amount of energy recovery from waste of Nigeria because physical and chemical composition of waste was not known. The calorific value of waste is calculated by Bomb calorimeter which was 17.23MJ/kg, results shows that on the basis of a 1500 ton capacity incineration plant, 700 kWh of electricity per ton of MSW combusted can be generated. **W.T. Tsai** et.al (2007). used the **International Panel on Climate Change (IPCC)** endorsed methodology to assess Bio-energy potential of landfill gas generated from different landfill sites in Taiwan and it was found that the amount of methane generated during 1992-1999 was 360 thousand ton per year and then it was 257 thousand tons in 2003 because some of the waste is recycled and incinerated during this time span. The results revealed that total LFG-to-electricity was around 1.6x10^8 kWh with the energy efficiency of 25%. **(Nigatu Rigassa. *et al.*, 2011)** observed that in addis abba one of the reasons for low performance solid waste management was the inadequate and inefficient operation equipment. Therefore it became necessary to analyze an efficient operating and burning system for high performance of solid waste management. **A.J. Ujam et.al. (2013)** designed a municipal solid waste fired steam boiler for effective utilization of municipal solid waste of Nigeria for power generation. Thermal analysis of a municipal solid waste boiler was done and amount of air required for combustion is calculated by using elemental composition of waste. Two methods namely Dulong's formula and Bomb Calorimeter were used for calculation of calorific value. Then

he concluded that waste with low moisture content increases efficiency of combustion. Heat loss of combustion and from boiler's external surface depends on atmospheric pressure and thermal power. The temperature of furnace should be maintained according to air supply during combustion.

## 4. CONCLUSION

The problem of waste management is becoming more and more complex day by day. There has been a significant increase in MSW (municipal solid waste) generation in the last few decades due to rapid population growth and economic development in the country. There are certain loopholes in solid waste management system due to lack of public participation, ignorance of this sector by municipal authorities and lack of funds. In order to increase the efficiency of solid Waste management, all the functional elements should be optimized. Waste should be separated at the source of generation itself which can be done by providing separate bins for each type of waste and by implementing door to door collection as primary method. A physical and chemical characteristic of waste helps in deciding the possible treatment options to be given to a particular Solid waste. Materials such as glass, metal and plastic can be recycled. Biodegradable waste with high moisture content is suitable for composting. Waste with high calorific value can be used as a effective source for biogas and power generation. By implementing these options we can reduce the amount of waste to be disposed in landfill sites.

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