Vol. XV & Issue No. 04 April - 2022
INDUSTRIAL ENGINEERING JOURNAL

MUNICIPAL SOLID WASTE MANAGEMENT IN INDIA: A REVIEW

Harshalkumar Satishbhai Patel

Dr. Tushar N. Desai

Abstract

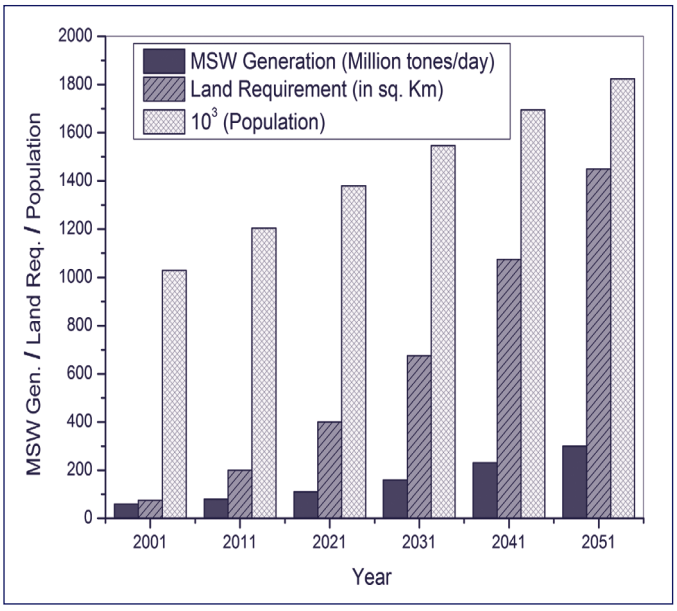
Municipal Solid Waste (MSW) is a combination of industrial and household waste generated by humans and it can be hazardous to the environment and living organisms. The solid waste generation rate in India varies between 0.3 to 0.6 kg/capita/day. The MSW generated in India have foremost categories of waste are Biodegradable waste, Recyclable material, composite waste and household hazardous waste. Municipal solid waste management (MSWM) is a key aspect of sustainable urban development. MSWM includes activities including the generation, storage, collection, transportation, treatment and disposal of solid waste. The purpose of this paper is to provide a comprehensive review of different methods used for the treatment of MSW in India. This paper also presents the current status of the MSWM and the requirement of sustainable waste management is discussed. The paper also provides the initiatives taken by the Government of India (GOI) along with future challenges for MSWM in India.

Keywords: Waste Management, Waste treatment, Waste Collection, Waste Recycling, Waste Disposal.

1. INTRODUCTION

Municipal Solid Waste (MSW) is a combination of industrial and household waste generated by humans. MSW includes paper, textiles, vegetable waste, cardboard, wood, leather, plastics, rubbers, metals, glass and electronic waste (Bhat et al., 2014). A trend of a significant increase in MSW generation has been recorded worldwide due to population growth, industrialisation, urbanization and economic growth. MSW generation has shown a positive correlation with economic development on a global scale in terms of kg/capita/day. The MSW generation has also increased extremely with improved lifestyle of humans and social status of the populations. (Sharholy et al., 2007). For disposal of these MSW, more land is required and disposal issues have become a major challenge (Idris et al., 2004). Municipal waste has a significant environmental effect and it can be extremely hazardous to living organisms, including humans (Misra et al., 2005). Municipal solid waste management (MSWM) is a key aspect of sustainable urban development. The primary objective of MSWM is to treat, reuse, recycle and recover a maximum amount of energy whenever possible (Eriksson and Bisaillon, 2011). MSWM includes activities including the generation, storage, collection, transportation, treatment and disposal of solid waste. But only four operations, i.e. waste production, processing, transport and disposal, are covered under the MSWM of most Indian urban areas. Due to the lack of adequate facilities for handling and disposal of the larger quantities of MSW generated daily in metropolitan cities, MSWM is currently in a critical phase (Kaushal et al.2012). The main source of MSW in India are the mega-cities (Chennai, Delhi, Mumbai, Kolkata) due to high density of population. The MSW generated in India have foremost categories of waste are Biodegradable waste, Recyclable material, composite waste and household hazardous waste. The volume and composition of wastes varies from one metropolitan area to another metropolitan area. The composition of MSW in India is 10 to 30 % recyclable, 30 to 50 % inert and 40 to 60% compostable. Also, the MSW generated in India is consist of Potassium, Nitrogen and Phosphorus. According to the Central Pollution Control Board report of the year 2018-19, Solid waste generation in India is 152076.7 TPD in year 2018-19. From the total 152076.7 TPD MSW generated, 149748.6 TPD (98.45%) MSW was collected, 55759.6 TPD (36.66%) was treated and 50161.33 TPD (32.98%) MSW was landfilled. The solid waste generation rate varies between 0.2 to 0.3 kg/capita/day in small towns/cities with population less than 0.2 million. For population ranges of 0.2 to 0.5 million, 0.5 to 1 million, and above 1 million the waste generation rate lies between 0.3 to 0.35, 0.35 to 0.4, and 0.4 to 0.6 kg/capita/day respectively.

Fig. 1. Prediction of MSW generation, Land requirement, and population from 2001-51 (Joshi and Ahmed, 2016)



The land requirement in the future for the disposal of MSW along with population growth and generation of MSW is shown in the figure 1 (Joshi and Ahmed, 2016). MSWM sustainability in countries like India is very difficult to attain, as the country faces a big development problem in the area of urbanization, industrialization and economic growth, which has culminated in the production of millions of tons of MSW (Kumar et al., 2017). In this study, comprehensive review of MSWM practices in India has been provided to elaborate current status and to identify problems of MSWM. It also provides the need of sustainable waste management to make MSW effective in India. In this paper, the future challenges for implementing MSWM and supportive government policy are also discussed.

2. REQUIREMENT OF SUSTAINABLE WASTE MANAGEMENT

A sustainable waste management system is required to develop economies in rapidly growing cities. Designing a waste management system capable to provide incentives to diverge from such harmful practices is a policy that is expected to ensure sustainability (Elsaid and Aghezzaf, 2016). The efficient design of sustainable waste management system is able to generate revenue quickly. The objective of the system is to reduce open dumping and uncontrolled burning practices that have damaging impacts on environment and human health. The requirement of sustainability in waste management is discussed below:

- to reduce harmful effects on land, water and environment.
- to reduce hazardous effects on the health of public residing in the cities.
- to reduce the possibilities of diseases and improving the aesthetic view of the cities.
- to enforce proper MSWM practices of collection, storage, segregation, transporting and disposal of waste.
- to treat the MSW, which has significant growth due to population, urbanization, industrialization efficiently.
- to encourage innovation and new technologies in MSW processing and disposal facilities.
- to spread awareness among Indian citizens regarding the MSW treatment and new techniques of waste disposal.

However, these practices of sustainability are difficult to achieve but with the support of eco-friendly technologies, this can be made possible. The main reason for unsustainable waste management in cities is due to following unscientific methodology. To achieve sustainability in waste management the detailed database related to MSW generated, collected, stored, transported should be prepared by municipalities on a Daily/Weekly/Monthly/Annual basis. From the database, the required number of manpower, equipment, area of land and other services can be made available for the cities. There should be an availability of a proper amount of landfill sites in every small city of India. Open dumping must be prohibited by imposing fine on it and to protect groundwater and soil from severe contamination with hazardous waste.

3. SOLID WASTE MANAGEMENT PRACTICES IN INDIA

1.1. Collection of Waste

The solid waste generated by houses is typically moved to municipal bins made of metal, concrete or combination of both. There are plenty of methods by which municipal authority can collect solid waste. Door to door collection, Regular time interval collection, Community bin collection, Scheduling of Vehicle (with provision of ringing of bell or music without exceeding noise levels). The efficiency of collection can be increased effectively by integrating above waste collection methods (Talyan et al. 2008). The MSW collection efficiency for year 2018-19 is 98.4% in India (CPCB Report, 2018-19).

1.2. Segregation of Waste

Segregation is a crucial step in the Solid waste management and it generally happens under hazardous conditions. There is no specific method to segregate Municipal solid waste at household level. Waste segregation is generally carried out by the unorganised sector and by waste producers. The improper handling of waste during transportation results into mixing up of segregated constituents during the transportation.

1.3. Recycling of Waste

The segregated waste has some recoverable materials like paper, glass, plastic and metal. The listed materials can be recycled efficiently by using of appropriate recycling method. In Pondicherry, the recyclable waste is sorted by rag pickers and recycled through different processes (Pattnaik & Reddy, 2010). Paper waste generally created by newspapers, cardboards, etc. Glass found in the form of food containers. Plastics usually comprise wide range of polymers that are used in food and drink containers. Plastics has a very short life cycle span. Aluminium and iron are mainly found in municipal waste. All the recoverable materials are recycled through suitable process.

1.4. Transportation

The solid waste is generally transported twice in week or once in week by container carriers. However, in rural areas bullock carts, hand rickshaws, compactors, open trucks and tractor with trailers are used for waste collection. The maintenance of vehicle used for waste transportation is necessary. as in event of breakdown of these vehicles the collection transportation and disposal efficiency reduce drastically (Joshi and Ahmed, 2016). There are limited transfer stations in some metropolitan e.g. Mumbai (Joseph, 2002).

1.5. Incineration

Indian municipal solid waste contains a high amount of organic constituents in a range of 40% to 60%, low calorific value content in a range of 800 to 1100 kcal/kg, high inert content in a range of 30% to 60% and high moisture content in a range of 40% to 60% (Kansal, 2002). The initial cost and operational cost of the incineration plant is also high. If MSW has low calorific value of waste, extra fuel is required for incineration. The first municipal solid waste incineration plant built in Timarpur, Delhi in 1987 but due to poor performance of plant it

could not run for a long time. However, small incinerators are used for burning hospital waste in India (Sharholy et al., 2005).

1.6. Pyrolysis

Pyrolysis is based on concept of waste to energy. It is a process of thermal degradation in the absence of air that produces recyclable products such as charcoal, oil / wax and fuel gases. In pyrolysis process the amount pf heat supply is depends upon the moisture content of waste. high moisture content requires more heat supply. Hence this process is suitable for waste having low moisture content like plastic, cloth, paper, yard waste etc. The initial cost and operational cost of pyrolysis is high also it has very little effect on the environment (Nandan et al., 2017).

1.7. Disposal

The unscientific disposal is the most usual practise to treat MSW in India. Statistics show that unregulated open dumping is typical feature in almost every cities of India (Kumar et al., 2009). The following methods are used for disposal in India.

1.1.1. Open dumping

In India, 90% of MSW is disposed in the form of open dumping on low lying areas and the edges of city roads due to lack of sanitary landfilling sites in the city (Kaur and Deswal, 2019). Flooding, surface water contamination during monsoon is resulted due to unscientific dumping.

1.1.2. Landfilling

A landfill is a region of land on which the waste is dumped. The aim is to prevent all interaction of the waste with the natural environment, in particular groundwater. In India, a significant rise in the degradation of environment due to open and poorly managed landfilling. However, landfilling will continue to be used in India for waste disposal, even though metropolitan cities like Chennai, Delhi, Kolkata, Mumbai and Chennai are facing issues of restricted land for the disposal of waste (Sharholy et al., 2008).

1.1.3. Biological treatment of organic waste

Composting is one of the oldest MSW treatment process in India (Hoornweget al., 1999). It is a biological process in which the organic matter of solid waste is decomposed and stabilized by microbes in the presence or absence of oxygen. Indian solid waste contains a high amount of organic constituents in a range of 40 to 60% as compared to 30% in developed countries. There are following methods of composting commonly practiced in India:

1.1.1.1. Aerobic composting

Aerobic composting is a bacterial degradation process of biological matter in the presence of air. It is the process in which the organic matter of MSW biologically converted into humus (compost) in the presence of humid air and a warm environment. The humus having a high nutrient value which is extensively used as fertilizer. There are two ways of Aerobic Composting one is labor-intensive and the other is mechanical. Labor-intensive composting is used in a smaller town and mechanical composting is used in big Indian cities. Indore city has MSW composting center with best maintained facilities. Mechanical composting units having capacity between 150 to 300 tons/day were also installed in Delhi, Mumbai, Kanpur, Vadodara and Bengaluru (Sharholy et al., 2007).

1.1.1.2. Anaerobic digestion

Anaerobic digestion is also known as biomethanation process. It is an effective and sustainable process for the treatment in subtropical climates of the biodegradable portion of MSW. In Anaerobic digestion, the biogas is produced by the degradation of organic matter due to stabilization. The biogas contains methane (55 to 60%) which can be used as fuel for power generation.

1.1.1.3. Vermicomposting

Earthworms are used for Vermicomposting on semi decomposed organic waste. By performing microbial enzymatic activity biodegradable organic matter is decomposed. Bengaluru has the largest capacity (100 tons/day) vermicomposting plant in India. While Hyderabad, Bangalore, Mumbai, and Faridabad consist smaller plants of vermicomposting.

1.8. Integrated solid waste management

Integrated Solid Waste Management (ISWM) can establish sustainable MSW service by using a range of collection, transport and treatment options. ISWM consists of special waste treatment and handling techniques. The major elements of ISWM are Biological treatment, Material Recycling, Thermal treatment and landfilling. The ISWM approach to create a sustainable waste management system is socially acceptable, economically affordable and environmentally effective. For restricting the damage to the environment due to MSW pollution, it is required to employ the best combination of available treatments and disposal options. Hence, efficient and effective MSWM techniques needed to process MSW which best meet current economic, social and environmental conditions of the municipality (Bhat et al., 2018).

4. GOVERNMENT INITIATIVES

The Central and State Pollution Control Boards with the Ministry of Environment and Forestry (MoEF) together are dealing with problems related to MSWM. The Environmental Protection Act-1986 consists of various sets of rules to improve the management of waste. MSWM comes under the state category because it is deemed to be public safety and sanitation under the Indian Constitution and due to this MSWM is responsible for the Urban Local Bodies (ULBs).

In the last three decades, GOI has taken important steps to manage solid waste in India are as follow:

- The GOI launched two separate bins to collect dry and wet waste separately. Blue bins are used to collect dry waste and Green bins are used to collect wet waste.
- The Central Public Health, MoUD and Environmental Engineering Institute together prepared a strategy paper which includes guidelines for treatment of waste, SWM, appropriate hygiene and efficiency in drainage system.

- National waste management committee was formed in 1990 to identify recyclable content in solid waste picked up by rag-pickers.
- The MoUD collaborated with NEERI in 1995 to prepare a manual on SWM which is called strategy paper.
- In March 1995, High Powered Committee was formed under the Chairmanship of Dr. Bajaj to develop long term strategy plan for SWM using appropriate technology.
- In 2002, GOI launched Clean Kerala Mission and in 2007 GOI launched Malinya Mukta Keralam Campaign.
- Technical Advisory Committee formed in 2005 under the High Court 's guidance delivered its study on the application of emerging technologies for improvement in the SWM.
- The National Capital Territory Delhi has passed Delhi Plastic Bag and Garbage act 2008 in order to impose the ban on plastic bags and restrict its usage to save environment.
- There were 553 vermicompost plants, 56 biomethanation plants, 13 waste to energy plants and 22 RDF plants established by GOI till 2014.
- The SMW rules 2000 was revised and MSWM rules 2016 formed by UoEF. The new MSWM rules 2016 gives more importance on segregation, collection, disposal and waste to energy conversion.
- To recycle E-waste Extended Producers Responsibility program is implemented (Joshi and Ahmed 2016).
- To reduce burden over landfill sites GOI has installed biomethanation and waste to compost plants in Bhopal.

5. CHALLENGES

Some of the future challenges for the management of MSW in India are following:

- The Increasing quantity of MSW and changing composition of MSW results due to population growth and improved living standards.
- The adverse impact of MSW on Environment (land, air, water, human health etc.)
- Increasing cost of MSWM and lack of proper level funding.
- Spreading awareness among residents to enhance segregation of MSW.
- Proper characterisation of MSW
- Implementation of MSWM rules at ground level.
- Resisting authorities for new landfill sites.
- Failure of waste to energy projects

6. CONCLUSION

The purpose of this paper is to provide a comprehensive review of different methods used for the treatment of MSW in India. The growing trend of composition and quantity of MSW is rising challenge for the MSWM authority. The key problems in the management of MSW due to lack of equipments and manpower are adequate collection, segregation and disposal of waste. The GOI has taken initiatives for MSWM to reduce the harmful effects of MSW on environment. It is also important to spread awareness among the citizens regarding segregation of MSW, as it is an important stage to perform successful operation of MSWM. For clean and eco-friendly Environment in the Indian cities, the sustainability in waste management is required. A sustainable waste management system is required to develop economies in rapidly growing cities. The efficient design of sustainable waste management system is able to generate revenue quickly. The perspective of sustainable solid waste management is to encouraging behaviour change in Indian citizen to minimize wastage and maximize reuse and recycling. A new survey on the generation and composition of MSW in India should be performed.

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AUTHORS

Shri Harshalkumar Satishbhai Patel, M. Tech, Sardar Vallabhbhai National Institute of Technology, (SVNIT), Ichchhanath Surat - Dumas, Road, Keval Chowk, Surat – 395 007 Gujarat, India
Email: patelharshal710@gmail.com, / 9979146971

Dr. Tushar N. Desai, Professor, Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, (SVNIT), Ichchhanath Surat - Dumas, Road, Keval Chowk, Surat – 395 007 Gujarat, India
Email: tushardesaisvnit@gmail.com

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