International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 06 | June - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

MUNICIPAL WASTE MANAGEMENT IN TIER-2 CITIES IN NORTHERN INDIA

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Abstract

Public health and environmental concerns, along with the sheer amount of waste being generated, have made managing municipal solid waste (MSWM) a significant task today. Due to institutional and financial constraints, research shows that many urban local bodies (ULBs) in India find it difficult to handle the country's high solid waste loads. ULBs frequently lack the infrastructure, finances, resources, and efficient plans required for improved solid waste management. India faces a number of difficulties in managing its municipal solid waste, including issues with garbage segregation, door-to-door collection, waste treatment technology, land resources, and appropriate disposal techniques. The Ministry of Environment, Forest and Climate Change and the Ministry of Urban Development (MoUD) have put in place a number of policies and initiatives to address these issues and enhance the nation's municipal solid waste management (MSWM) system as it is now. The Municipal Solid Waste Management Rules were first released by the Environment Ministry in 2000. They have since been updated and are now known as the Solid Waste Management Rules 2015. To help cities and towns plan and execute efficient MSWM systems in compliance with the 2015 SWM Rules amendment, the MoUD has also created a draft MSWM manual. Due to insufficient enforcement by regulators and a lack of awareness among stakeholders, many policies and programmes frequently fall short of their objectives. This essay provides a comprehensive review of solid waste management and highlights important facets of the policies and initiatives the Indian government has put in place to address the issues in this field.

Introduction

The global trend of significant increase in municipal solid waste (MSW) generation is a result of population growth, industrialization, urbanization, and economic development. There is a positive correlation between MSW generation and economic development on a global scale, measured in kg/capita/day. The rapid industrial growth and migration of people from rural areas to urban centers are contributing to the increasing urban population. The annual increase in waste generation is directly linked to the growing population and urbanization. The amount of municipal solid waste (MSW) produced per person has also significantly risen due to improved lifestyles and social status in urban areas. This has led to a greater need for land for the disposal of solid waste, making disposal issues increasingly difficult to manage. *(Pamnani, 2, February 2014)*

A total of 160038.9 TPD of solid waste are produced in the nation; of that, 152749.5 TPD are collected with an efficiency rating of 95.4%. Of the waste collected, 18.4% is landfilled and 50% is processed. 50655.4 TPD, or the remaining 31.7% of the total garbage generated, is not being reported. *(Annual Report 2020-21 on Implementation of SWM rules 2016)*

The increasing volume and varying quality of urban solid garbage make management more difficult. The local administrative body (LAB), which is headed by the elected officials of the city or town, is in charge of Municipal Solid Waste Management (MSWM) in India. The population

classification of Indian cities and towns is based on this.

The RBI divides cities into six categories according to the size of their populations. Cities in Tier I have a population of 100,000 or more, while cities in Tier II, which have a population of 50,000 to 99,000, Cities with 20,000–49,999 residents are under category III. Cities having a population of 10,000–19,999 are included in tier IV. Cities with 5,000–9,999 people are classified as tier V, and those with fewer than 5,000 people are classified as tier VI. *(saini, 2024)*
Local governing bodies such as panchayats and municipalities bear the primary responsibility for providing SWM services. Inadequate funding, ineffective technologies, and a lack of awareness in society are the primary reasons for the inadequate management of solid waste. The issue is further exacerbated by the increasing population and waste production.

The collection, transportation, storage, and disposal of solid waste are all included in municipal solid waste management. Poor collection and transportation cause MSW to build up in multiple areas, posing health and environmental risks. Around the world, governments are working to improve solid waste management domestically. *(Pamnani, 2, February 2014)*

The primary responsibility for providing solid waste management (SWM) services lies with local governing bodies such as panchayats and municipalities. Inadequate funding, ineffective technologies, and a lack of awareness in society are the primary reasons for the poor management of solid waste. This problem is being exacerbated by the increasing population and waste generation.

It is now crucial to give waste reduction top priority. One option for garbage segregation is to use the door-to-door pickup method. This is the greatest way to keep the waste in a form that will aid with recycling and composting as much as possible. The most widely utilized waste management techniques include reduction, incineration, disposal in water, and dumping on land. These techniques do not, however, work with every kind of trash.
The functional elements of the SWM system are as:

- Waste generation
- Waste handling & separation at source
- Collection
- Separation, processing and transformation
- Transfer and transport
- Disposal (by discarding, destroying, processing, recycling, reusing, or controlling wastes) *(The Energy and Resources Institute, 2022)*

Need of the study

1. Urbanization

Compared to developed countries, emerging countries are more affected by the expanding urban population. 31% of India's total population lives in urban areas, with 377 million people living in urban areas. Global research indicates that urbanisation accelerates as the proportion of a nation's population living in urban areas rises above 25% of the total population. From 18% in 1961 to 31.2% in 2011, the proportion of people living in urban areas increased.

2. Public Health and Safety

One of the primary reasons waste management is essential is for the protection of public health and safety. Inadequate waste disposal can result in numerous health hazards and dangers. When waste is not managed correctly, it can pollute soil, water, and air, causing the spread of diseases and infections. For example, if hazardous waste is not disposed of properly, it can release harmful substances into the environment, posing significant health risks to people living in nearby areas.

3. Environmental Protection and Preservation

Preserving and safeguarding the environment requires efficient waste management. The environment can be negatively impacted by improper garbage disposal, as seen by contaminated soil, water, and air that endangers

ecosystems and species. Recycling is one appropriate trash disposal strategy that we can put into place to reduce pollution, protect natural resources, and keep the environment safe for coming generations.

4. Recycling

Another important factor in waste management is the reduction of waste in landfills and environmental pollution. When paper, plastic, glass, and metal are recycled, it helps to preserve natural resources, decrease greenhouse gas emissions, and conserve energy.

5. Economic Benefits and Job Creation

Effective waste management is essential to protecting priceless resources. Communities can reduce their dependency on new raw materials and mitigate the environmental effects of resource extraction by promoting recycling and resource recovery. When recycling replaces the production of new materials, it saves energy, water, and other resources. Moreover, recovering resources from garbage helps create a more sustainable method of resource management. Examples of this include recovering metals from electronic waste and creating energy from organic waste. Communities can reduce the environmental impact of resource extraction while preserving biodiversity and natural resources by putting effective waste management procedures into place.

6. Resource Conservation and Sustainability

Waste management plays a crucial role in resource conservation and sustainability. Effective waste management includes the recycling and reuse of materials to reduce the need for raw materials, preserve natural resources, and decrease the volume of waste in landfills or incinerators. *(biotrux)*

Framework and Strategy for Solid Waste Management

1. Environment (Protection) Act, 1986

The aim of this legislation is to safeguard and enhance the environment and related issues. It authorizes the Central Government to create authorities [under section 3(3)] responsible for preventing all forms of environmental pollution and addressing specific environmental concerns. This act serves as a comprehensive framework, with multiple central institutions collaborating to ensure efficient waste management in India, with the primary goal of achieving effective waste management.

2. National Environment Policy, 2006

The National Environment Policy 2006 was developed in response to India's constitutional commitment to a clean environment, as outlined in Articles 48 A and 51 A and reinforced by various judicial interpretations. It is acknowledged that ensuring a healthy environment is not solely the duty of the State, but also the responsibility of every citizen. Therefore, a collaborative approach is essential for effective environmental management in the country.

3. Solid Waste Management Rules, 2016

The Union Ministry of Environment, Forests and Climate Change (MoEF & CC) announced the replacement of the Municipal Solid Wastes (Management and Handling) Rules, 2000 with the new Solid Waste Management Rules (SWM), 2016 on April 08, 2016. The new rules include six categories of waste management: Solid Waste Management (SWM), plastic waste, e-waste, biomedical waste, hazardous waste, and construction and demolition waste management. *(The Energy and Resources Institute, 2022)*

Technologies for treatment of solid waste

Technologies for MSWM

Currently, there are various processing methods available for managing municipal solid waste, including composting, bio-methanation, recycling, refuse derived fuel (RDF), gasification, incineration, pyrolysis, engineered landfills, and

more. Each of these technologies has both positive and negative implications, and the selection of the most suitable method depends on the population of the city and the quantity of waste. It is important to consider the challenges associated with separating, collecting, and transporting the waste to the location where large scale composting or biogas generation plus composting can be conducted. The efficiency of recycling and composting is significantly impacted by the lack of source separation. Biodegradable organic material makes up half of the collected waste and can be used for composting or the production of biogas. In order to keep this wet waste out of landfills and to produce biogas, power, and compost for use as a nutrient, it must be composted or biomethanized. The 18–20% of waste that is recyclable and reusable is not separated from the other waste because it takes a lot of energy and time to separate it from mixed rubbish, which is typically not done. The recycling industries have a number of difficulties, such as (i) their reliance on physical labour and (ii) the manufacturing of recycled goods that fall short of quality criteria set by regulations. It is not possible to process mixed garbage using recycling or composting techniques.

Disposal of MSW

In India, open burning and rubbish dumps remain the main methods of disposing of waste, which can discharge poisonous liquid leachate and hazardous gases into the air. In low-lying locations outside of cities, many towns and cities dispose of their waste without taking the necessary safeguards. Degradation of the environment and public health results from local authorities disposing of more than 80 percent of collected rubbish in unsanitary dump yards, according to the Planning Commission (2014). A significant contributing factor to the problem of municipal solid waste, especially in large cities, is the scarcity of land available for garbage disposal. The lack of available land for waste disposal is a significant issue for managing municipal solid waste, particularly in large cities. According to the Ministry of Finance's 2009 position paper on solid waste management in India, it is estimated that over 1400 sq.km of land will be needed for solid waste disposal by 2047 if proper measures are not taken. The 2015 draft Solid Waste Management Rules outline criteria for the location of sanitary landfills, and it is recommended to consult the Central Pollution Control Board's guidelines for selecting landfill sites. However, finding new landfill sites is a major challenge, partly due to the "not in my backyard" (NIMBY) phenomenon, where people desire effective waste management facilities but do not want them near their homes. *(Singh)*

Methods of solid waste disposal and management are as below:

1. Open burning of Solid Wastes

The unregulated burning of solid waste releases a dangerous mix of emissions into the air and land, posing threats to people, workers, and the environment. It is believed that open burning of waste is a common practice in low- and middle-income countries, but there is a lack of systematic and scientific study and evidence on this. The scientific foundation for modeling the impact of emissions from open burning is also not well-developed. Among the different types of waste and disposal methods examined, the greatest risk to human and environmental health was found to be from exposure to uncontrolled open burning of waste. Most combined risks and exposure occur at or near open dumpsites.

2. Sanitary Landfills

Sanitary landfilling is a waste management technique that involves the disposal of solid waste in specially designed areas called sanitary landfills. It is a method where various waste materials, including household trash, construction debris, and industrial waste, are carefully placed and compressed in specific locations. Landfills are engineered sites with measures in place to minimize the impact on the environment and public health. The process of landfilling begins

with the selection of suitable land for the landfill site, taking into account factors such as distance from residential areas, water sources, and geological stability. The waste is then transported to the landfill and systematically arranged in layers or cells. As the waste accumulates, it is compressed to reduce its volume and create more space for additional waste.

Types of Sanitary Landfill

Trench Method

The best conditions for implementing this sanitary landfill method are on flat terrain with easy excavation and a low groundwater table. A trench measuring 2 to 5 meters wide and 2 meters deep is excavated to allow for easy transportation over the trench, with a width of 1 to 2.5 times that of a tractor. The length of the trench is determined based on site conditions, anticipated truck arrivals, and daily waste generation. Once the waste is stacked and compacted, the excavated soil is used to fill the trench and cover the earth.

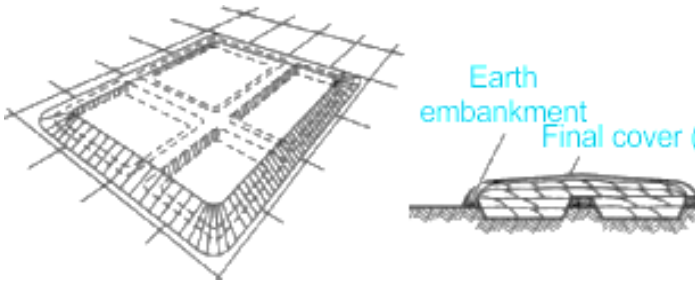

Fig.1 Trench Method

Area Method

Sanitary landfilling using the Area method is most effective in areas that already have natural depressions, like quarries, ravines, and valleys. The garbage is compressed and placed into these depressions, then covered with compacted Earth. This process is repeated until the depression is filled. The Earth cover can be obtained from borrow pits located on the site.

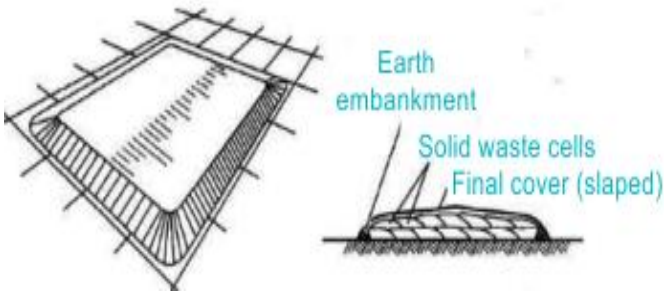

Fig.2 Area Method

Ramp Method

This approach, which is a variation of the area method and trench method, is suitable for flat or gently sloping terrains. It involves constructing a ramp of moderate height, 30 meters in length, and approximately 15 meters wide. A shallow excavation is created at the base of the ramp using a bull clam or similar equipment. In order to increase the maneuverability of the tractor, a valley-like ditch is carved across the width of the ramp. Trucks drive to the top of the ramp and deposit their loads into the ditch. Multiple vehicles can simultaneously unload their cargo into the ditch with the assistance of the ramp. Once the process is completed, the tractor compacts the waste and simultaneously covers it with earth, integrating it into the ramp for use by vehicles the next day.

Fig.3 Ramp Method

3. Incineration

The process of thermal treatment involves utilizing high temperatures to break down or eliminate waste. Its primary goal is to thermally break down the waste and harness energy in the

form of heat or electricity, ultimately reducing the environmental impact of residual waste. Incineration, a form of combustion, involves the oxidation of waste at temperatures ranging from 900 to 1200 ºC, resulting in the production of carbon dioxide, water, and a residue known as 'ash'. While incineration reduces waste volume by 90%, it also produces significant amounts of gaseous and particulate pollutants.

4. Composting

In developing nations like India, the organic fraction makes up a sizable portion of the garbage produced, and because of poor waste management techniques, only a small percentage of the overall waste volume is treated. Two categories have been established for the composting technique: traditional composting techniques are included in the first category, while innovative composting techniques are included in the second. *(Singh J. , 09-09-2017)*

Conclusion and recommendations

The objective of this research is to provide an overview of municipal solid waste (MSW) and other significant factors such as obstacles to integrated solid waste management (SWM), complexity of public-private partnership (PPP) mode, contribution of rag-pickers, current MSWM practices, and regulations related to waste management in India. In emerging economies like India, it is crucial to devise and execute affordable and sustainable SWM strategies. Insufficient knowledge, lack of awareness, inadequate funding, lack of accountability, and ineffective implementation of laws and regulations are the primary causes of failure in managing solid waste. Challenges such as selecting suitable disposal sites, securing adequate financial support, and managing human resources can be addressed by improving capacity, enhancing procedures, and providing training. Addressing the issues related to adopting appropriate technologies and lack of skilled workforce will require a realistic timeframe for development, and both central and state governments need to take action to strengthen solid waste management. It is important to consider potential complexities during implementation in order to make decisions and strategies based on practical realities.

Challenges

1. Awareness to enhance segregation:

Raising ecological consciousness and involving citizens in separating waste at its origin, collecting it door-to-door, and disposing of it in appropriate bins is crucial. Heightened awareness plays a significant role in municipal solid waste management (MSWM) and enhances the effectiveness of waste management. This phase is vital in the entire MSWM process as it aids in the proper handling of solid waste, ultimately contributing to its success. However, the current situation in India indicates a lack of garbage segregation at the source, resulting in various environmental issues. This makes it challenging to separate waste at transfer stations, landfills, or treatment sites.

2. Characterization of municipal solid waste:

India is a big country with a variety of climate zones, dietary customs, and living standards, which leads to the production of garbage of all kinds. Too far, there are no thorough studies that cover most Indian cities and towns to comprehend the type of trash generated and how it is disposed of in landfills. Because of this, decision-makers have less information at their disposal, which makes it challenging to offer appropriate solutions for handling the unique waste kinds produced in each region.

3. Urbanization and lack of appropriate level funding:

The increasing population poses a challenge in providing sufficient infrastructure in urban areas and selecting new landfill sites. Many existing landfill sites in metropolitan cities are operating

beyond their capacity, and the problem is worsened by insufficient financial support for waste management. Due to financial constraints, Urban Local Bodies (ULBs) lack the necessary infrastructure to offer effective solutions.

4. Implementation of rules at ground level:

ULBs have been found to be insufficiently implementing MSWR according to several government reports, making it challenging to properly manage MSW. There is a necessity to establish a specialized team of officers and trained staff for ULBs with expertise in MSWM. Providing sufficient training and practical experience would allow them to pinpoint obstacles at the implementation level and take necessary measures.

5. Resistance for notification of new landfill site:

Local citizens are resisting the notification of a landfill site in their area, making it challenging to select a new site. Additionally, all existing landfill sites are operating beyond their capacity. (Singh)

Conclusion:

The focus of the Sustainable Solid Waste Management (SSWM) policy agenda should be on promoting changes in behavior among citizens, elected officials, and decision makers to reduce waste and littering while increasing opportunities for reuse and recycling. SSWM is primarily a matter of managing people, and relying too heavily on technological solutions to address the waste management problem will only prolong the time it takes to see positive outcomes.

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