

Municipal Solid Waste Management in Urban Areas: Challenges and Impact on Public Health

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ABSTRACT-Municipal solid waste (MSW) generation has significantly increased as a result of the fast urbanization and population growth in both developed and developing nations, creating serious problems for public health and urban administration. Inadequate infrastructure, a lack of source segregation, a lack of money, lax enforcement of policies, and public disinterest in sustainable waste management are some of the major issues related to municipal solid waste management (MSWM) in metropolitan areas that are examined in this study. Open dumping and burning are examples of improper waste disposal methods that have had detrimental effects on the environment, including soil, water, and air pollution, all of which have an immediate effect on human health. Inadequate waste management techniques in urban environments have been connected to the rise of vector-borne diseases, respiratory ailments, and waterborne infections. The study emphasizes the necessity of sustainable and integrated MSWM solutions that include decentralized waste processing systems, technological innovation, community involvement, and more stringent regulatory frameworks. Cities may lessen the negative environmental consequences of solid waste and drastically lower the hazards to public health posed by improper management of urban garbage by tackling these issues comprehensively.

KEY WORDS: municipal solid waste, urban waste management, public health, waste segregation

I. INTRODUCTION

Human demands are increasing day by day due to the increase in demands there we have an increase in facilities and increase in facilities attain the higher rate of waste whether in any of the department as we can mainly observe it in physical waste which is mainly inorganic nowadays waste is totally inorganic and non manageable so that the waste production is the major concern nowadays, as in old times the waste is likely to be organic which is dumped into soil and within some time all of the waste degrade and there we have the proper management and the inorganic waste is also noted to be recycled waste which we can recycle and reuse for the further use. Now we also have another major issue that is segregation we can't segregate the waste whether it is of use or not. Waste management is the major aspect playing role in maintenance of pollution and much more The increasing limit of population is increasing the pollution and waste also , waste is non manageable when it is fully inorganic because it cannot be dump easily cannot be settle easily. Government initiative of Municipal Cooperation is there for the Waste Management and segregation of the waste is also done for the usage of recycled waste and much more the major concern is that how the waste should be discarded as per the responses we get to know that people think hat landfills would be an great thing to discard waste openly but as we know that waste is not having the quality that it'll discard and totally we couldn't depend on the soil itself!

For the degradation of the waste the effective management of municipal solid waste (MSW), which is defined as the everyday items discarded by the public, such as household garbage, commercial waste, street

sweepings, and construction debris, is one of the most pressing challenges that come with urbanization, one of the most defining features of modern development. As urban populations expand rapidly, particularly in developing nations like India, the volume and complexity of urban waste have increased significantly, making MSWM a crucial issue for public health, environmental sustainability, and urban governance.

High population density, increased commercial activity, and a concentrated demand for resources are characteristics of urban centres that all lead to the production of significant amounts of garbage. Waste management systems are frequently ineffective due to a lack of public knowledge, inadequate infrastructure, inadequate planning, and low financial resources. Consequently, open dumping, uncollected waste, clogged drainage systems, and poorly maintained landfills are among the issues that cities commonly face. In addition to causing environmental damage, these deficiencies also seriously endanger public health, especially for low-income groups that live close to landfills or do not have access to basic sanitary facilities.

The contamination of the air, water, and soil, which promotes the spread of diseases, is one of the most obvious consequences of inadequate MSWM. Methane and other toxic gases are released when organic waste breaks down, contributing to both air pollution and climate change. Toxic pollutants including dioxins and furans, which are known to cause respiratory disorders and other long-term health concerns, are released during the open dumping and burning of waste. Furthermore, leachate from uncontrolled landfills can contaminate drinking water with diseases and heavy metals by leaking into groundwater sources. In addition to harming human health, these pollutants upset the natural equilibrium, affecting both plants and animals.

In slum regions and informal settlements, where solid waste is rarely collected on a regular basis and basic sanitation is frequently lacking, the impact on public health is especially severe. Diseases including cholera, diarrhoea, typhoid, dengue, and malaria thrive in areas with accumulated trash and stagnant water, making children and the elderly particularly susceptible. Furthermore, waste pickers are directly exposed to dangerous materials, which can result in long-term diseases, injuries, and social exclusion. Many of these workers do not have health insurance or protective gear.

Several institutional and systemic challenges hinder effective MSWM in urban areas. These include a lack of coordination among municipal departments, insufficient enforcement of environmental regulations, absence of segregation at the source, and limited public-private partnerships. Technological limitations also restrict the adoption of sustainable practices like recycling, composting, and energy recovery. Furthermore, citizens often display apathy or resistance toward waste segregation and environmentally responsible behavior due to limited awareness and behavioral inertia.

Despite these challenges, there is growing recognition of the need for integrated and sustainable waste management systems that involve multiple stakeholders—government agencies, private enterprises, non-governmental organizations, and the community. Emerging technologies such as waste-to-energy plants, bio-methanation units, and AI-based sorting systems are showing promise in improving waste processing efficiency. Public awareness campaigns and educational programs are also beginning to foster behavioral change at the grassroots level.

II. Municipal Solid Waste Management Rules in India

Waste Management Methods

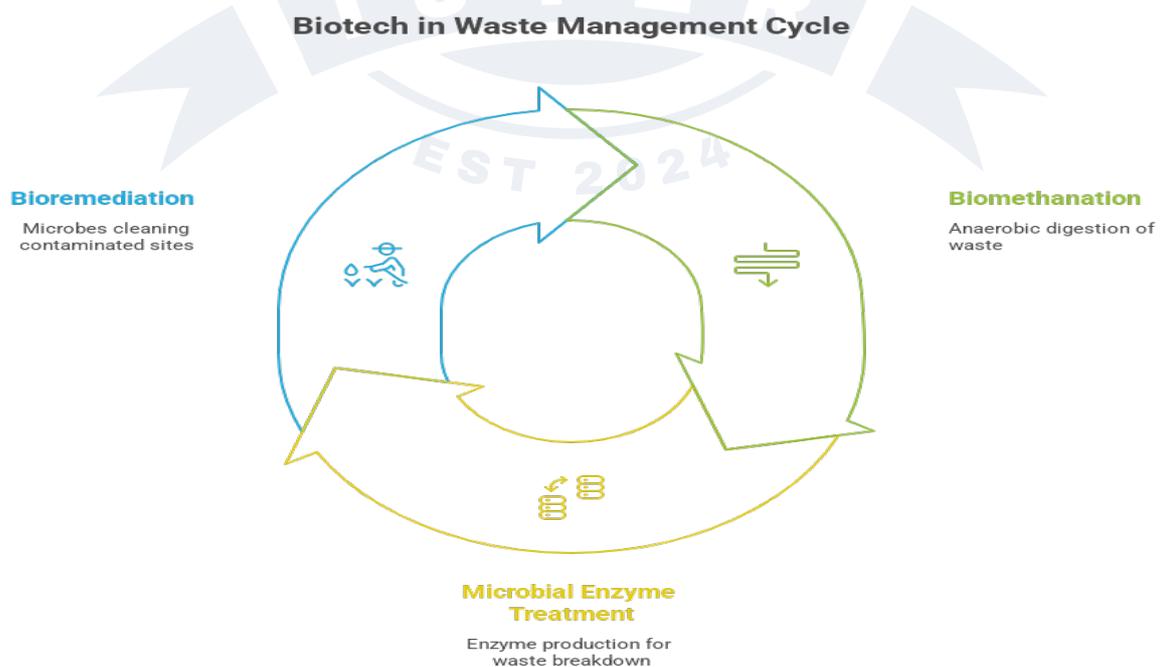
Characteristic	Biodegradable	Non-biodegradable	Domestic Hazardous
Storage	Separate bins	Separate bins	Separate bins
Disposal	Waste collector	Waste collector	Waste collector
Responsibility	Pay charges	Pay charges	Pay charges
Actions	No littering	No littering	No littering

Made with Napkin

Biotech Link With SWM

Biotech play a very vast role throughout the SWM journey as we know SWM is not only about management it could also added up having some techniques some methods or we can say some treatments include;

- ❖ biomethanation [anaerobic digestion] this includes the microbial breakdown of biodegradable waste in the absence of oxygen.
- ❖ microbial enzyme treatment in this on the enzyme is produced through microbes which can break down cellulose, fats, proteins,in food waste and sludge.
- ❖ bioremediation in this treatment we generally use microbes to clean land or it is used to treat contaminated soil .



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III. Benefits of Using Biotechnology Tools in SWM

The integration of biotechnology tools in solid waste management (SWM) has emerged as a transformative approach to address the increasing volume of waste while promoting sustainability. One of the primary benefits is the enhanced bio-degradation of organic waste, where biotechnology utilizes microbial consortia and genetically engineered microorganisms to accelerate the decomposition of organic material. This process, particularly through composting and anaerobic digestion, leads to the generation of valuable byproducts such as compost and biogas, significantly reducing the volume of waste that needs to be disposed of in landfills.

Moreover, biotechnological approaches help in reducing landfill volume, as biological treatments can efficiently break down the organic fractions of municipal solid waste (MSW), lowering the overall quantity of waste sent to landfills. This, in turn, prolongs the lifespan of existing landfills, reducing the environmental burden associated with waste disposal. Additionally, biotechnology plays a pivotal role in generating value-added products from waste. These include biogas, which can be used for energy production, bio-fertilizers from composting, bio-fuels from nitrocellulose waste, and even bio-plastics such as polyhydroxyalkanoates (PHAs), all of which contribute to the circular economy by turning waste into reusable resources.

Another crucial advantage of biotechnological tools in SWM is their ability to mitigate greenhouse gas emissions. Unlike traditional land-filling, where the decomposition of organic matter produces methane—a potent greenhouse gas—biotechnological systems like anaerobic dig-esters can capture and convert methane into biogas, which can be used as a clean energy source. This not only reduces the carbon footprint of waste management but also contributes to climate change mitigation efforts.

Biotechnology also provides a cost-effective and sustainable alternative to conventional waste management practices. Compared to energy-intensive chemical or thermal treatments, biotechnological processes are often less expensive and can be implemented on a smaller scale. For instance, decentralized systems like home biogas units or community composting facilities offer low-cost, saleable solutions, especially in resource-limited settings. Furthermore, these processes are eco-friendly and non-toxic, as they eliminate the need for harmful chemicals commonly used in other waste treatments, resulting in safer byproducts that are less harmful to the environment.

Additionally, biotechnology tools can assist in improving waste segregation and recycling through innovative biosensors and real-time waste characterization. This enables more efficient sorting of biodegradable and recyclable materials, optimizing the entire waste management process. Another significant benefit is pathogen reduction and homogenization, especially in the treatment of medical or hazardous waste. Certain biotechnological processes, such as microbial treatments, can neutralize pathogens, ensuring that waste is safely processed without posing public health risks.

Lastly, biotechnology aids in the bio-remediation of contaminated sites. Technologies like bio-leaching and phyto remediation use microorganisms and plants to clean up contaminated waste sites, such as those affected by heavy metals or hazardous chemicals, providing an environmentally friendly alternative to traditional methods of site remediation. By enabling such processes, biotechnology contributes to cleaner ecosystems and a more sustainable waste management framework.

In summary, biotechnology tools offer a wide range of benefits for SWM, including waste volume reduction, energy production, pathogen control, and the generation of valuable products, all while fostering more sustainable and environmentally friendly waste management practices.

Biotechnology is the field which is multidisciplinary field work interdisciplinary so that the waste could be manage accordingly.

3Rs rule for waste management

An effective solid waste management relies on the principles on the 3Rs [REDUCE,REUSE,RECYCLE] these principle aim to minimize waste generation and promote sustainable use of resources thereby reducing the burden on landfills and the environment

- REDUCE
- REUSE
- RECYCLE
- **REDUCE** – the first and most important step is reducing the amount of waste generated at the source , reduction not only cuts down the volume of waste but also conserves natural resources and energy.
- **REUSE** - reuse materials extends their life cycle and reduce the demand for new products . item such as containers, bags , clothing and furniture can be reused multiple times before disposal municipal initiative like community swap events or second hand market can foster a culture of reuse
- **RECYCLE** – recycling involves processing waste materials to produce new product , thereby diverting waste from landfills and conserving raw materials. Municipal recycling programs typically include paper , plastics , metals and glasses .

WASTE MANAGEMENT STRATEGIES



Health Concerns Regarding Solid Waste Management

The improper solid waste handling affects waste workers, rag pickers, residents and it can lead to direct or indirect health problems the problems could be in any aspect as respiratory and lung issue due to the

burning of the waste caused especially plastic and mixed waste, they release toxic gasses after burning like furans, carbon monoxide they can lead to asthma, bronchitis, if got severe it can cause death and on an further researches we get to know that they can cause skin and eye allergies or can get more worse than that. There are so many concerns regarding it as we can see that. the burning of waste release toxins substance like dioxins and particulate matter. which are harmful to the respiratory and cardiovascular system. long term exposure can lead to chronic conditions such as – asthma, bronchitis and even lung cancer. Hazardous waste, such as electronic waste (e-waste), industrial chemicals, and medical waste, contains toxic substances that can cause severe health problems when improperly handled. These include heavy metals like mercury, lead, and cadmium, which can cause neurological damage, kidney failure, and developmental issues in children.

Procedure of Solid Waste Management



The solid waste management has a particular aspect and a particular procedure of managing waste in different hubs where we collect the waste then we segregate it and give the pre-treatment to it and they will divide if needed to recycle they will go into another dumps and if it is an organic waste then it will segregate it to another dump or if it is a recyclable waste it get shifted to different factories accordingly to reduce production of pathogenic materials and so they can use it. The mixing tank or homogenizing tank, then waste feeding into anaerobic tanks then it transfer to anaerobic digestion there we have 2 production – biogas, sludge where biogas production leads to biogas utilization, the sludge production leads to sludge utilization.

Solid Waste Management Practices in India

Since India is a developing country and as we can see the increasing no. of the population we have large resources of techniques and facilities but due to lack of awareness, political issues, lack of attention toward the duties which assign to the govt. officers, and the govt. initiative was clean the areas properly and they have made an municipal committee and there are some of the hurdles due to which India is not able to cope up in waste management as compared to other countries. If some effective measure can taken lots of things should be done for the growth and development of the society such as proper recycling of waste, making goods from solid waste by proper treatment, which rises employment for unemployed peoples. A part from these stringent laws should be passed in this regard for proper disposal and treatment of waste. Waste should be treated correctly if we move on an deep note to waste management we can see that govt. is looking forward for the managing portals and different AI tools for their ability to manage waste management properly, No new plan of any residential, commercial area should be passed until and unless it has proper place for disposal and treatment of its waste. In India there is a strong case of private sector participation in this area and private sector can come with its expertise, technology, and capital, improved and efficiently managed service. Public participation is of paramount importance and can provide big results if seek properly.

IV. Conclusion

Solid waste management has emerged as one of the most pressing environmental and public health challenges in urban and rural areas alike this review has examined the current practices, challenges, and opportunities within municipal solid waste management system. poor planning limited financial resource, lack of infrastructure and insufficient public awareness continue to hinder efficient waste disposal in many municipalities, moreover, the increasing volume of waste due to population growth and consumption patterns has added pressure on existing waste management systems.

To overcome these issues, it is essential to adopt an integrate solid waste management [SWM] approach that emphasize the 4Rs- Reduce, Reuse, Recycle and Recover, while also incorporating scientific methods like composting, sanitary, landfilling and waste to energy technologies. public-private partnership, community participation and strict regulatory framework play a crucial role in making waste management practices more effective and sustainable.

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