

Review Article

Solid Waste Management, Challenges and Possible Sustainable Solutions

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A B S T R A C T

The undesirable or worthless solid materials produced by human activity in residential, commercial, or industrial locations are referred to as solid waste. It is made up of a vast range of types of both biological and inorganic substances. These materials are classified on the basis of types of material such as plastic, paper, metal, organic waste, glass, toxic, non-toxic, flammable, radioactive elements, industrial waste, domestic waste etc. The only factors contributing to the high and rising rate of solid waste generation are urbanisation and population increase, and managing this waste properly is a significant issue. We have to tackle this issue now otherwise; it may create hazardous and incurable problems. There is a widespread problem in many developing and developed countries in the world regarding disposal of waste material. Because of increase in population, industrialization wastes are generated in societies. About 7.6 million tons of wastes have been produced worldwide and out of which 9-13% of which have been recycled. The creation of waste, as well as its storage, collection, transportation, processing, and disposal, are all included in solid waste management. Ineffective solid waste management has a negative influence on citizens' quality of life, accelerates the depletion of natural resources, pollutes the environment, and deteriorates public health.

The only factors contributing to the high and rising rate of solid waste generation are urbanisation and population increase, and each city's municipal corporation faces significant challenges in properly managing this waste. Household solid waste poses a significant risk to health and facilitates the spread of infectious diseases. In order to safeguard public health, the environment, and natural resources, solid waste management is an issue that needs to be handled correctly. This article focused on the sources and constituents of solid waste, the kind and volume of trash disposed of, disposal techniques, and the effects of solid waste on health. It also provides an overview of the importance of solid waste management, the challenges it faces and potential sustainable solutions.

Keywords: Solid Waste, Collection, Disposal, Management, Environment, Sustainability

Introduction

Solid waste is any unwanted or wasted stuff disposed of in solid form through communal activities. Solid waste, sometimes referred to as trash, street, sweepings, ashes, and other industrial wastes, is any undesired or discarded item in solid form Figure 1. Wastes are divided into three categories based on their physical states: solid, liquid, and gaseous. Municipal wastes, hazardous wastes, medical wastes, and radioactive wastes are the different categories for solid wastes. People are moving from rural to urban areas due to rapid industrialization and population growth, producing hundreds of tonnes of solid trash annually. More solid trash is produced as a result of changing lifestyles and growing urbanisation. One of the main environmental issues facing both industrialised and developing nations is solid waste management. Planning, funding, building, and running facilities for garbage collection, transportation, recycling, and ultimate disposal are all part of managing solid waste.¹⁻⁶

There are three categories for solid waste. In light of its:

- Origin (residential, commercial, industrial, building, or institutional).
- Contents (such as plastic paper, glass, metal, and organic stuff).
- Potential for hazards (radioactive, infectious, flammable, non-toxic, etc.).



Figure 1. Solid wastes degrades the environment

The management of solid waste is a global concern that impacts every individual on the planet. Ineffective solid waste management and disposal contributes to pollution of the air, land, and water on all fronts.^{7,12} Waste disposal contaminates land and water supplies in urban areas. Air pollution is mostly caused by the uncontrolled burning of solid waste Figure 2. Improper solid waste disposal also poses health and safety risks. Diseases like cholera and dengue fever can be transmitted by insects and germs drawn to the trash.



Figure 2. Solid wastes causing environmental pollution

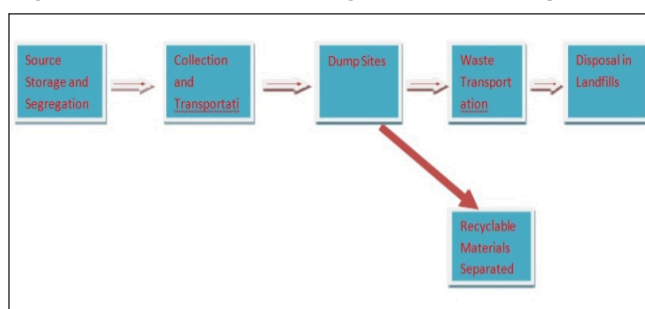


Figure 3. The schematic sketch illustrates the steps carried out in managing solid wastes

Methods of solid waste disposal: A number of waste disposal options are available in the form of repetitive disposal technology Figure 3.

1. **Land Filling:** This is the best popular method use for solid waste disposal. This method is useful for dumping of all types of residual wastes, organic and inorganic wastes. When the landfill is full, it is covered with layers of sand, clay, topsoil and gravel.
2. **Incineration:** This is used for burning of solid wastes at high temperatures until the wastes are converted into ashes. This method useful for management of solid waste by municipalities and institutions.
3. **Composting:** The biological process of composting involves the conversion of degradable organic waste into a substance akin to humus by microorganisms, primarily fungi and bacteria. This final product, which resembles dirt and has a high carbon and nitrogen content, is beneficial for plant growth. You can use organic fertiliser in place of conventional fertilisers; it works best for veggies. It facilitates soil cultivation and improves the soil's capacity to retain water. It promoted greater plant nutrient retention in the soil. It keeps the soil warm in the winter and cool in the summer. Keeping the soil covered also helps to avoid soil erosion Figure 4.

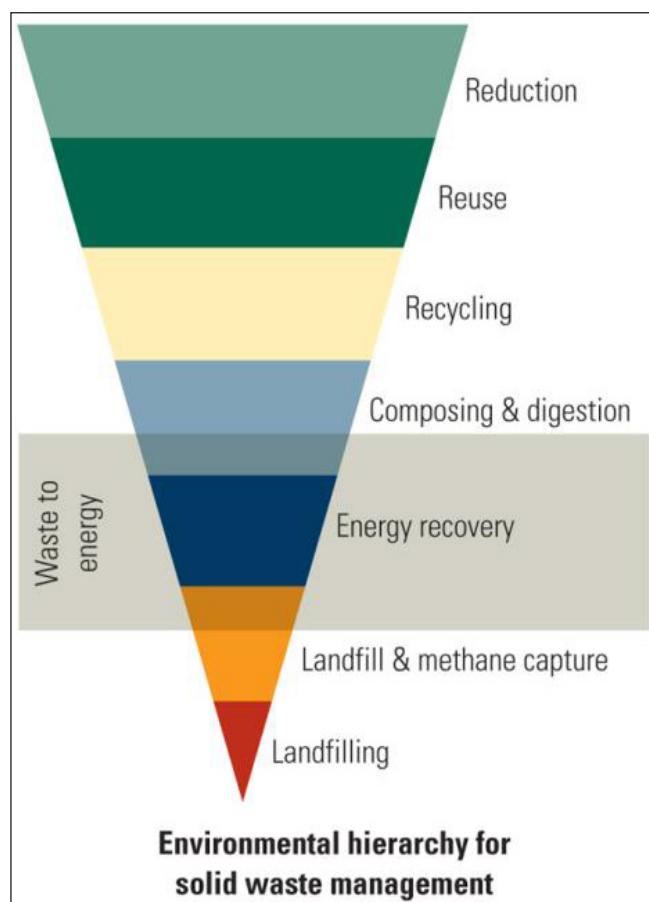


Figure 4. Solid waste management approach

Sustainable Solutions for Solid Waste Management

When it comes to waste management, methods of trash reduction, reuse, and recycling are the best choices Figure 5. Using these techniques can have a lot of positive effects on the environment. They lessen or stop the release of pollutants, cut down on greenhouse gas emissions, preserve resources, save energy, and lessen the need for waste treatment technologies.¹³⁻¹⁷ As a result, it is advised that the waste management plan adopt and include these techniques.



Figure 5. R approach for solid wastes handling

Challenges in Solid Waste Management

Urbanization

The rapid urbanization of many regions has led to a surge in waste generation. Urban areas face the challenge of managing large quantities of waste efficiently, which often strains existing infrastructure.

Lack of Infrastructure

Inadequate waste collection and disposal infrastructure is a common problem in many developing countries. This results in the improper disposal of waste in open areas or water bodies, exacerbating health and environmental issues.¹⁸⁻²¹

Consumer Behavior

Changing consumer behavior is another challenge. A culture of excessive consumption and the use of single-use items contribute to the rising volumes of waste. Encouraging responsible consumption and waste reduction is critical.

Convert Waste to Energy Technology

The waste management sector can benefit from technological advancements. Smart waste bins, automated collection systems, and waste-to-energy technologies Figure 6 are innovations that can improve efficiency and sustainability.

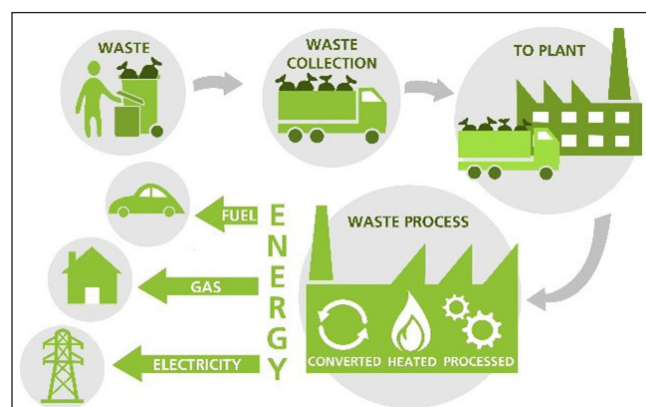


Figure 6. Converting waste to energy technology

- **Composting:** Organic waste constitutes a significant portion of municipal solid waste. Composting can divert this organic matter from landfills and transform it into valuable compost for agriculture.
- **Waste-to-Energy:** Waste-to-energy technologies, such as incineration and gasification, can convert non-recyclable waste into electricity or heat. When properly managed, these technologies can help reduce landfill reliance and greenhouse gas emissions.
- **Public Awareness and Education:** Educating the public about the importance of responsible waste management is crucial. Awareness campaigns and school programs can instill the values of waste reduction and recycling from an early age.

- **Government Policies and Regulations:** Effective waste management requires clear policies and regulations. Governments should enforce waste separation, recycling targets, and penalties for illegal dumping to incentivize responsible practices Figure 7.²²⁻²⁴



Figure 7. Sustainable solutions for Solid waste management

Conclusion

One crucial social service for the preservation of the environment is solid waste management. The amount of solid trash produced is growing more quickly due to industrialization and population growth. As a result, appropriate steps should be made to minimise trash, such as routine recycling or disposal. The challenge of disposing of waste has gotten worse as cities have grown more populated. This leads to the conclusion that garbage is not being fully stored at the source since individuals would rather dispose of it as it is generated. Individuals are unwilling to separate their garbage at home. Although the municipality offers door-to-door collection services, the citizens are not content and the service is insufficient. The landfill site is not the appropriate place to dispose of rubbish. It is a major worry that infectious diseases spread during the rainy season each year as a result of insufficient solid waste management, making people sick. Enacting enabling laws, having a supportive institutional framework within government, and having adequate funding are all necessary for successful solid waste management. Solid waste management is a vital component of modern urban living. By addressing the challenges and adopting sustainable solutions, we can minimize the adverse impacts of waste on people health, environment and climate change. The responsibility lies not only with local governments and waste management authorities but also with individuals and society to embrace a more sustainable approach to waste. As our cities continue to grow and our planet faces environmental challenges, efficient solid waste management is not just a necessity; it's a path to a more sustainable future. Effective solid waste management is not only crucial for maintaining public health and the environment but also for conserving resources and reducing the carbon footprint.

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