

“Waste Management and Treatment: Strategies, Stakeholders and Legal Framework”

**Bhuvnesh Soni
Vichar Samiti*

***Akanksha Malaiya
Vichar Samiti*

****Vanshikha Mahana
University of Petroleum and Energy Studies*

Abstract

Waste management is a step by step process which involves collection of waste, segregation of waste, transportation of waste, recycling, disposal of waste and monitoring whereas the necessary steps to assure that the waste or garbage has the least possible impact on our environment are referred to as waste treatment.¹ This paper starts with an introduction as to what is waste, its types, and the waste management system and then provides a wide analysis of the process of waste management and treatment systems. The author has highlighted the various steps involved in the process of the waste management system and the multiple methods including technology-based that are adopted nowadays for the treatment of wastes and their disposal. This paper also discusses the need of waste management and the treatment and disposal of wastes. Moreover, this paper also mentioned the various challenges in the path of waste management and the role of NGOs and government in overcoming these challenges. Furthermore, the author has discussed in this paper about how the practice of waste management helps in reducing the hazardous impact on our environment. Then, the paper tends to discuss the legal provisions enshrined in various statutes in India related to waste management. After the legal provisions, the author has discussed some important landmark case laws wherein waste management has been discussed. The paper also discusses the 6 R's involved in the waste management system. The paper then discusses the sustainable practices in the waste management system, which describes sustainable waste management and its importance. The paper then suggests the changes required to improve the practices of the waste management system in India. Last but not the least, there is a conclusion of the whole discussion in the paper and has mentioned the need for encouraging the waste management and treatment system in India.

¹ TOOLSHERO, <https://www.toolshero.com/management/waste-management/> (last visited Apr. 24, 2022).

Introduction

Waste can be defined as an unwanted substance that is no longer useful for its intended utilization or any material which is at the end of its product life cycle and then disposed thereof. In other words, wastes are those materials that need to be eliminated in order to secure the health of the people and to protect the environment. In India, rapid urbanization and population growth contribute to the increase in municipal solid waste. However, this rapid increase in the generation of waste can be reduced by proper management of waste. Article 21 of the Indian Constitution provides the provision for the right to clean air, water, and food, which aims to provide a clean and healthy environment.² Therefore the management and treatment of waste are very important before disposing of the waste in order to reduce the environmental damage. For the management and treatment of waste, the classification of waste is an essential factor. Waste can be classified mainly into two types: Biodegradable waste and non-biodegradable waste.

Biodegradable Waste: They are degradable wastes whose primary source is plant and animal sources. These wastes can be degraded by other living organisms. For example, fruit or vegetable peels, leftover food, slaughterhouse waste, etc.

Non-biodegradable Waste: Wastes that cannot be degraded by other living organisms are known as non-biodegradable waste. For example, plastic wastes, aluminum cans, vehicle tyres, polystyrene, etc.

Now, various kinds of waste can be put into this classification to make the process of waste management and treatment easier. They are as follows:

- **Domestic Waste:** Domestic waste is generated as a result of personal activities or daily activities of human life. For example, kitchen waste, laundry, household waste, etc.
- **Industrial Waste:** Industrial waste is generated by the processes involved in manufacturing and industrial works. For example, scrap metals, oil, concrete, chemicals, etc.
- **Inert Waste:** Inert waste means a waste that cannot be degraded in nature, which is neither biologically nor chemically reactive. For example, construction and demolition waste, etc.
- **Non-hazardous Waste:** Non-hazardous waste includes such waste which can cause no harm to the environment at its disposal, and these wastes do not possess dangerous characteristics (non-toxic).

² INDIA CONST. art. 21.

- **Hazardous Waste:** Hazardous wastes, at their disposal, causes harm to the environment because they possess dangerous characteristics and toxicity.
- **Radioactive Waste:** Any material or waste product which has traces of radioactivity, or wastes that are contaminated with intrinsic radionuclides, for which no utility can be foreseen currently. Radioactive wastes are fatal for the environment and human beings because of their nature of emitting radioactive rays. For example, “spent” uranium fuel, which is highly radioactive. They are also known as nuclear waste.
- **Sanitary Waste:** Sanitary wastes are wastes used for sanitation, for example, menstrual waste, diapers, used condoms, toilet papers, paper napkins, etc.
- **Medical Waste:** Medical wastes are generated at various healthcare facilities like hospitals, medical clinics, or medical research centers. Medical wastes can be sub-divided into infectious waste, pathological waste, sharps waste, and pharmaceutical waste. Medical wastes sometimes include radioactive waste too.
- **Solid Waste:** Solid wastes are the unwanted “solid-state materials” generated from human activities from mainly municipal or industrial sources. Examples include plastic, metals, etc.
- **Liquid Waste:** Liquid or fluid wastes are the waste materials that are in the liquid state. They include household wastewater, sewage, liquid chemicals released from industries, etc.
- **E-Waste:** E-waste can be defined as electric equipment or electronic waste products which fully utilized and cannot be used further. For example, damaged or discarded computers, mobile phones, refrigerators, etc.

The process of waste generation cannot come to an end but it will increase day by day due to the population explosion. Therefore, the management of waste is the need of the hour and very crucial for the protection of the environment and health of the human beings. In India, waste management is taken care of by the Ministry of Environment, Forests, and Climate Change, Government of India. On a local level, urban bodies of Municipalities are responsible for the management of waste. Waste Management in India is based on three principles, “precautionary principle”, “polluter-pays” and “sustainable development”, to make the process of waste management environment-friendly and sustainable. Hazardous wastes are required to be treated before the disposal or release of such wastes. For example, chemical wastes from the industries are hazardous to be released without treating them. Therefore, the treatment of waste before its disposal is a very important step in waste management.

Steps involved in the process of the waste management system

The process of waste management involves the treatment of various solid and liquid wastes by the application of various techniques to make sure the step-by-step process of waste management including proper segregation and recycling is effective and functional. Following are the steps involved in the process of waste management:

- **Waste Generation** - It includes discarded substances or materials, whether or not they are recycled or disposed of in a landfill, at a later stage.
- **Waste handling at the source** - Waste handling or waste processing includes the separation of waste components into various sub-categories for energy recovery.
- **Storage of Waste** - Storage of waste means the interim containment of the waste in a manner that is prescribed, after the generation of waste and before the collection and disposal of waste.
- **Collection and Transport** - This process of collection and transportation of wastes involves the storage of wastes at the generation points and various pick-up points, pick-up by the cranes, trucks, etc., and truck transfer to a transfer station of wastes.
- **Waste Treatment** - The waste is then segregated and treated before sending it for disposal.
- **Recycling and Reuse** - Various waste materials or garbages at this point can be reused as secondary material, like, glass, paper, plastics, etc. These materials should be segregated before recycling the same. Then the rest of the materials are recycled and used as recycled products. Various paper and paper products are recycled to be used as roofing felt, insulation and wallboard, etc. Plastics are recycled into poly bags sheets, insulating material, etc.
- **Landfill Disposal** - A landfill is an engineered pit, where waste is layered down to fill the pit with waste, and then compacted and covered for the final disposal of waste.

And the waste is finally disposed of.

Methods involved in the treatment of wastes and their disposal

Treatment of waste is necessary for the easy disposal of waste. The waste treatment process reduces the volume and toxic nature of the waste. This process helps in transforming the waste into a more convenient form for their disposal. There are various methods of treatment and disposal of the waste, and the selection of the method for treatment and disposal of waste depends upon the form, nature, quantity, and composition of the waste or garbage.

- **Thermal Treatment of Waste** - This process includes heat processes to treat the waste materials. Using heat processes reduces the volume of the waste making the disposal process easy. Here are some of the thermal waste treatment techniques:

I. Incineration - The burning of waste is known as incineration. This method involves the combustion of the waste in the presence of oxygen. This process is largely used by the industries to burn the waste in the large incinerators to ash, flue gas, or heat, which reduces the volume of waste and makes the transportation of waste even easier, and cuts the transportation costs. It also helps in reducing harmful greenhouse gas emissions and contributes to the protection of the environment.

II. Gasification - The process of gasification of waste involves the transformation of a carbon-based waste into other forms of energy without actual burning of waste. In other words, it converts solid or liquid waste into a gaseous form by a chemical reaction. Gasification does not cause air pollution.

III. Pyrolysis - A process involving thermal degradation of waste into a gaseous or solid state without oxygen or air. This procedure is carried out between 500 to 600 degrees Celcius of temperature. The plastics and vehicle tyres decompose into pyrolysis oil, pyrolysis gas, and carbon black.

IV. Open Burning - This process of thermal treatment involves the burning of waste in an open area like open pits, outdoor furnaces, barrels, etc. Incinerators used in this process do not have pollution control devices and cause excessive air pollution by releasing greenhouse gases.

- **Landfills and Dumps** - This method of disposal of wastes requires burying the waste in the land. Landfills and dumping grounds give rise to air and water pollution which badly affects the environment, and can be hazardous for human and animal life.

I. Sanitary Landfills - Sanitary landfills are the most popular method of waste disposal. These landfills are hoped to minimize or lessen the possibility of waste disposal posing environmental or public health risks. Land features act as natural buffers between the environment and the landfill at these locations. Sanitary landfills pose the least risk to human health and the environment, but their construction costs are higher than those of other garbage disposal techniques.

II. Controlled Dumps - Controlled dumps are similar to sanitary landfills in many ways. Many of the conditions for being a sanitary landfill are met by these dumps, although one or two may be missing. The capacity of such dumps may be well-planned, but there is no

cell planning. There may be no or only a limited amount of gas management, rudimentary records management, or regular coverage.

III. Bioreactor Landfills - Recent technical advancements have resulted in bioreactor landfills. To accelerate garbage decomposition, these landfills employ improved microbial processes. The constant input of fluids is the controlling characteristic that ensures appropriate moisture for microbial digestion. Recirculating landfill leachate is used to add the liquid. When leachate is insufficient, liquid waste, such as sewage sludge, is employed.

- **Composting** - Composting, which is the regulated aerobic breakdown of organic waste products by the activity of tiny invertebrates and microbes, is another often used waste disposal or treatment method. Static pile composting, vermin composting, windrow composting, and in-vessel composting are the most prevalent composting methods.
- **Anaerobic digestion** - Anaerobic Digestion decomposes organic materials via biological mechanisms as well. Anaerobic Digestion, on the other hand, decomposes waste in air or oxygen-free and bacteria-free atmosphere, whereas composting requires air to allow microorganisms to flourish.
- **Resource Recovery** - The process of recovering desirable or useful waste objects is known as resource recovery. These abandoned goods are subsequently processed to extract or recover minerals and resources, or to transform them to usable heat, power, or fuel.
- **Recycling** - Recycling is the procedure in which there is a conversion of waste items into new products in order to reduce energy consumption and the consumption of pure raw components. The third component of the “Reduce, Reuse, and Recycle” waste pyramid is “recycling”. Recycling aims to reduce energy consumption, landfill volume, environmental pollution, greenhouse gas emissions, and the preservation of natural resources for sustainable use.
- **Plasma Gasification** - Another method of waste treatment is plasma gasification. Plasma is primarily a highly ionized or electrically charged gas. Lighting is a sort of plasma that may reach temperatures above 12,600 degrees Fahrenheit. A barrel uses typical plasma torches running at +10,000 °F to create a gasification zone up to 3,000 °F for the transformation of solid or liquid waste into syngas in this waste disposal process. The molecular bonds in waste material are degraded during plasma gasification treatment as a result of the great heat in the vessels and the elemental components. This method of waste disposal provides renewable energy as well as a slew of other advantages.

These are the processes through which waste can be treated and disposed of in a sustainable manner.

Need for waste management and the treatment and disposal of wastes

Waste management is essential because it protects the environment from the damaging effects of waste's inorganic and biodegradable elements. Waste mismanagement can result in freshwater contamination, soil erosion, and air pollution. If waste is collected and managed properly, it can be recycled. Solid wastes like plastic, glass, and paper can be separated into different categories and processed to create new goods, saving natural resources. Furthermore, when this trash is not recycled, it often ends up in a landfill or ocean, posing a health and environmental risk to humans and marine life. Sewage treatment in most parts of the world is inadequate, resulting in eutrophication and beach closures.

Waste management, its treatment, and its disposal will not only protect natural resources, wildlife, and human life, but it will also have a beneficial economic impact because more jobs will be created as a result of the effective waste management system. Waste is disposed of in garbage disposal sites in developed countries, whereas waste in poorer economies frequently ends up on streets and vacant places. When untreated trash is released into the air, it poses a threat to the environment and has a negative impact on infrastructure. Waste management is becoming increasingly significant with the passage of time, not just for the protection of the environment but also as a rising business for an economy.

Traditional waste management strategies cannot be used in the present scenario. With the passage of time, waste management, treatment, and disposal strategies have evolved, and it is essential to consider how important waste management is for our long-term sustainability.

Challenges in the path of waste management

Management of waste in India is currently in a very poor state since the best and most appropriate waste collection and disposal procedures are not being implemented. There is a scarcity of skilled waste management specialists and there is a dearth of training in solid waste management. In India's current waste management systems, there is also a lack of accountability. Municipal corporations in India are in charge of handling municipal solid waste, but their budgets are insufficient to pay the costs of constructing proper garbage collection, storage, treatment, and disposal systems. In India, attaining successful waste management is hampered by a lack of strategic municipal solid waste management plans, waste collection/segregation, and a government financial regulatory framework.

Lack of enthusiasm and a lack of environmental knowledge have stifled innovation and the adoption of innovative technology that could improve waste management in India. In India,

people's perceptions toward garbage are also a key impediment to better solid waste management.

Solid waste management has become a big issue in India as a result of the rising population and, in particular, the development of megacities. India now relies on insufficient waste infrastructures, the informal sector, and the dumping of waste. There are significant challenges with public involvement in garbage management, as well as a general lack of public accountability for waste. It is important to raise awareness in the community and modify public perceptions toward waste in order to build effective and long-term waste management systems. Waste management that is both sustainable and economically successful must enable maximum resource extraction from garbage while also ensuring the proper disposal of residual waste through the creation of engineered landfills and waste-to-energy plants.

India confronts issues in the waste management sector, including the framework of legislation or policies on waste management, waste technology selection, and the accessibility of adequately qualified workers. India will continue to suffer from poor waste management and the consequences for human health and the environment until these basic prerequisites are satisfied.

Overcoming these challenges

The utilization of wastes as resources, with optimized value extraction, recycling, restoration, and reusing, is important to India's waste management vision. Waste management must be the responsibility of Urban local bodies, with the Urban local Commissioner and Chairman being directly accountable for waste management system efficiency. Waste management must be viewed as a critical function that requires long-term funding in Indian society. The benefits of appropriate waste management investments must be demonstrated in the case made to an Urban local body for a properly funded system.

If Solid Waste Management in India is to develop, it would require a strong and independent administration to handle waste management. Changes will not occur without explicit monitoring and control. Strong waste regulations have the potential to spur innovation. The waste management industry must comprise appealing and lucrative enterprises with clear performance standards set by the Urban Local Bodies, as well as hefty fines for waste management systems that do not function properly. A waste disposal tax must be imposed on waste generators to collect funds for waste managing companies and infrastructures.

Information on future waste quantity and categorization is important since it influences the suitability of various waste management and treatment strategies. Direct and indirect collection, as well as adequate methods for monitoring collection, transport, and disposal of waste, need state-level procurement of technology and transportation.

Littering or dumping of garbage in the streets is a huge issue in India, with serious health consequences, and it needs to be stopped in order to overcome the challenges of the waste management system in India.

To enable considerably more effective value extraction and recycling, management of waste must include segregation of waste at the source. Separating dried (inorganic) and wet or liquid (biodegradable) garbage would be beneficial and should be the waste producer's obligation.

At every level, there is a necessity to provide training and capacity building. The necessity of waste management, the repercussions of inadequate waste management on the environmental system and human health, and the role and duties of each person in the waste management system should be understood by all school children in the country. As a result, responsible individuals will grow who see waste as a resource potential.

Legal Provision for waste management

India is experiencing rapid growth in urbanization, the industrial sector, and its development. Thus, waste generation is increasing day by day. So, there is a dire need of disposing of these wastes in order to avoid environmental issues and to ensure the principle of sustainable development is taken care of. Ministry of Environment, Forest, and Climate Change (MoEFCC) coordinates with the State Pollution Control Boards in various states to regulate the waste management and disposal activities keeping in mind the rules and regulations laid down in various legislations for the management of waste. Some of the legislation, rules, and regulations are as follows:

- **The Environment Protection Act, 1986**

This legislation authorizes the Central Government to manage and regulate all kinds of waste. It contains the most important provisions regarding waste management and disposal. Some of the related provisions are as follows:

1. Section 7 primarily restricts polluting the environment. This section states that “no person carrying any activity should emit or discharge environmental pollutants in excess of the prescribed standards”.
2. Section 9 of the Act states that “if any event takes place which harms the environment through any foreseen or unforeseen event, the person responsible for the harm is duty-bound to prevent or alleviate the pollutant, discharged as a result of such event”.

3. Section 9(3) of this Act talks about the “Polluter-pays principle” which says that “any expense which has been incurred to restore the environment to its natural state shall be paid by the person who is responsible for such degradation”.
 4. Environmental Protection Rules, 1986 were drafted by the government using the authority granted by the Environmental Protection Act, 1986. The government can use these powers to issue precise instructions without amending the fundamental Act.
- **The Hazardous Wastes (Management, Handling, and Transboundary Movement) Rules, 2008**

The Rules hold the occupier of a hazardous location responsible for the safe and proper disposal of environmental waste. The occupier is the person in control of a factory, unit, or industry that generates toxic waste as a byproduct of its operations. The occupier must sell or deliver the hazardous material to a reprocessor or recycler that has been approved by the government to safely dispose of the trash. Anyone involved in the storage, packaging, collection, destruction, conversion, processing, or other types of activities must obtain permission from the State Pollution Control Board. The garbage can be stored for up to 90 days by recyclers, occupiers, re-users, and re-processors.

Only after completing a valid registration from the Central Pollution Control Board (CPCB), hazardous waste can be sold or transferred. The CPCB must also be notified if waste is to be used as a form of energy.

The Basel Convention, to which India is a signatory, governs the trans-border transportation of toxic waste. Hazardous waste imports for disposal in India are restricted by law, however, imports for reuse, recovery as a source of energy, and recycling are permitted under certain conditions. Hazardous waste can be exported from India, but only with the importing country’s prior informed approval.

- **The Plastic Waste (Management and Handling) Rules, 2011**

This set of rules controls the use, manufacture, and recycling of waste. Any plastic product that has been abandoned after it has reached the end of its useful life is considered plastic waste. The Rule applies to all distributors, consumers, retailers, and makers of plastic products in the same way. Every manufacturer of plastic products and recycler is required by Rule 9 to register with the State Pollution Control Board. Every three years, this registration must be renewed. No store is allowed to give away plastic bags for free, according to Rule 10. This is done to ensure that people only use plastic bags when absolutely necessary. The Plastic Waste Management standards also stipulate

the classification of plastic items, such as compostable, recyclable, or virgin plastic, as well as thickness and color.

- **Biomedical Waste (Management and Handling) Rules, 1998**

The objective of these Regulations is to ensure that biomedical waste is disposed of safely. Any waste or byproduct formed during the medication, immunization, or treatment of humans or animals, or during research work, is referred to as bio-medical waste. Schedule I of the Rules divides biological waste into categories such as microbiological and biotechnological waste, human anatomical waste, animal anatomical waste, abandoned pharmaceuticals, chemical-related waste, and so on.

These rules are applicable to various medical institutions like hospitals, nursing homes, veterinary clinics, dispensaries, pathologies, laboratories, etc.

Bio-medical wastes cannot be mixed with any other sort of waste, according to the Bio-Medical Waste Rules. Bio-medical wastes cannot be retained for more than 48 hours without being treated, according to the standard regulation. Every occupier or institution dealing with biological waste is required by Rule 8(1) to obtain permission from the State Pollution Control Board. Furthermore, Rule 5(2) requires all institutions covered by the rules to put up treatment facilities such as a microwave system, an autoclave, and so on.

- **The E-Waste (Management and Handling) Rules, 2011**

The main objective of E-Waste Management is to create a system that manages e-waste in an environmentally responsible manner by regulating the issue of e-waste recycling and disposal. In India, e-waste management is a major concern. India is becoming a hotspot for the IT sector, thanks to its increasing economic and technical advancements. This generates a large amount of e-waste, which must be disposed of. E-waste is often illegally brought into India, exacerbating the problem. Manufacturers and consumers are both subject to the E-waste Rules. It's also worth noting that there are a lot of people who buy electronic devices in bulk. Many large corporations have totally automated their systems and rely heavily on technological gadgets to achieve their objectives.

E-waste is defined as any electrical or electronic device that has been rejected after being used or disposed of, as defined by Rule 3 (k). This category also includes byproducts that are wasted during the production process. Rule 4 requires that producers of electronic and electrical items seek clearance from the State Pollution Control Board.

- **The Batteries (Management and Handling) Rules, 2001**

The Batteries Rules were notified in order to put in place a system for disposing of lead-acid batteries. Manufacturers, recyclers, dealers, importers, assemblers, bulk users (such as organizations and departments purchasing more than 100 batteries), and consumers are all subject to the Rules. Every consumer is required by Rule 10 to “return spent batteries to the dealer, manufacturer, recycler, or labeled collection facilities”. Bulk consumers are also required to report their usage to the State Pollution Control Board every six months. According to Rule 6, “if a recycler wishes to import used batteries into India for recycling, he must first seek Custom clearance”.

These rules and legislations regulate the waste management process. However, there is a need for some more stringent rules and regulations to regulate the process of waste management, treatment, and disposal, so that the process is more sustainable and pollution-free.

6 R’s involved in the waste management system

With the increasing waste generation, it is becoming even more important that we learn to save resources and develop a proper waste reduction strategy. The plan of managing garbage as a resource is possible if the 6 R’s of Waste Management are followed. “Reduce”, “Reuse”, “Repair”, “Recycle”, “Rot”, and “Residual Management” are the six R’s.

- **Reduce:** The most effective strategy to minimize waste is to “reduce” waste generation first. The greatest way would be to avoid wasting resources such as water, power, raw materials used to make another item, and so on. By adopting this method, waste might be contained.
- **Reuse:** If possible, make it a practice to “reuse” raw resources. Takeout meal containers made of plastic could be used to grow a small plant. It is important to come up with innovative reusable solutions for items that end up in landfills.
- **Repair:** When a machine isn’t well-maintained, it might use a lot of energy and waste a lot of resources. If a correct plan is in place to maintain machinery with proper maintenance and servicing or “repair”, resources such as fuel can be saved.
- **Recycle:** The present tendency of purchasing the most up-to-date electronics results in the waste accumulation of older ones. Rather than tossing things away and contributing to waste, giving your old electronic items to a nearby school or education center for “recycling” is a good idea.

- **Rot:** The new “rot” is an intriguing green environment concept. Instead of throwing your food waste in the trash, create a composting place in your garden that may be used as soil humus.
- **Residual Management:** Even sewage waste could be properly handled if the right technology was adopted. The goal of “residual management” is to plan ahead of time to identify the best way to dispose of garbage without harming the environment.

Sustainable waste management

The term “Sustainable waste management” strives to keep products in use as long as feasible while reducing the quantity of solid waste disposed of in landfills or incinerated. However, waste is generated even before products are manufactured in our current linear economy, and a more comprehensive strategy for sustainable waste management must concentrate on the entire lifecycle of a product to help lessen the adverse environmental, social, and economic impacts of 21st-century consumption.

Sustainable waste management is very necessary to practice nowadays, especially in an economy like our Indian economy. It’s a systematic strategy for socioeconomic development that opposes the take-make-waste model and seeks to detach growth from finite resource usage. Sustainable waste management not only addresses the broader difficulties of a linear consuming society but also provides more direct remedies to the numerous issues that garbage creates.

Conclusion

As per the trends of the growing population in India, the quantity of waste generation by human beings in the next coming years will be doubled. Therefore, waste management is becoming even more important to conserve the environment and reduce environmental pollution. The governments and the authorities should focus on the principle of sustainable development while making legislations and policies for the proper waste management, treatment, and disposal. Maintaining sustainability while waste disposal can prove to be advantageous in the terms of the recovery of energy from the waste products and protecting the environment at the same time by applying the rule 6 R’s of waste management. However, the inadequacy of proper infrastructure for waste management has become a barrier to sustainable waste management. Apart from infrastructural issues, public participation and lack of responsibility toward waste is also a major issue in the path of sustainable waste management. Thus, we need to spread awareness among the public and change the attitude of people toward waste. Sustainable waste management must enable maximal value extraction from waste while also ensuring the safe disposal of remaining waste through the creation of engineered landfills and waste-to-energy plants. India confronts issues in the waste management sector, including waste legislation, waste technology adoption, and the accessibility of sufficiently qualified workers. India will continue to suffer from poor

waste management and the consequences for human health and the environment until these basic prerequisites are satisfied.

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