J. Qual. Assur. in Agri. Sci. Vol. 1(1), 9-13, 2021
www.jqaas.org
https://doi.org/10.52862/jqaas.2021.1.1.2

CHALLENGES AND OPPORTUNITIES LINKED WITH WASTE MANAGEMENT UNDER GLOBAL PERSPECTIVE: A MINI REVIEW

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Article Received: 06-06-2021, Revised 10-07-2021, Accepted 07-08-2021

ABSTRACT

In today's world, Waste production and its handling has become a great challenge. Rapid urbanization and conversion of rural land into housing societies creates bulk of waste withing a short span in any area. While increasing population, increase in waste is a topic of discussion in developed as well as developing countries and it may become the biggest problem in the near future for the world. It is emphasized that only municipal solid waste will be 3.40 billion tons by 2050. Different types of waste are produced and it's handling also requires different techniques. Now a day, different techniques are used to overcome this problem. These techniques reduce the waste by weight and severity of its effect, but they also release end product that maybe harmful for the environment. This review will discuss the techniques like landfills, incineration, composting, recovering, combustion, energy production, plasma gasification etc. Different techniques have different merits and demerits. However, every technique required specific input running cost and it may be varied from area to area and country to country due to economic crises in developing countries. This review covers the types of waste, waste management opportunities, and challenges as well as the benefits of waste management techniques.

Keywords: Waste generation, Waste management, Disposal techniques, Global Problem, Pollutants

INTRODUCTION

Waste is any material that is unserviceable to the producer (Basu, 2009). Waste is a fundamental human activity product. Waste is generated because of defective production procedures which lose important resources on an ongoing basis (Cheremisinoff, 2003; Amasuomo and Baird, 2016). The generation of the rising number and complexity of wastes are another environmental danger to cities. According to data, 1.3 billion metric tons of waste are produced (Soltani et al., 2015). In many situations, waste in developing nations is not handled properly since towns and municipalities are unable to cope with the speed of waste creation (Chalmin and Gaillochet, 2009). According to future predictions, the world's garbage output might reach 2.7 billion tons by 2050, with Asia producing one-third of that, with a substantial portion of that created in China and India (World Bank, 2005). In 2018, the World Bank predicted that the output of municipal garbage will rise by up to 70% from 2.01 to 3.40 billion tons in 2050. Table 1 shows the five major waste producing countries in 2017. Waste management is a significant global problem for governments as cities grow increasingly populous on a day-to-day basis. As a result of waste overproduction, our ecosystem has suffered (Pervin et al., 2020). Improper dumping of waste and its burning release harmful substances and dioxins which causes human health problems and contamination of the environment like air pollution (Akmal et al., 2021). In this review paper, different types of waste produced and their management methods are discussed. This mini-review also covers the challenges faced during waste management as well as the beneficial aspects of waste management on different aspects of human life.

Types of waste

There are different types of waste generated in various activities:

a) Municipal solid waste: It is produced from offices, shops, schools, hotels, households, and other institutions. Food waste, plastic, paper, metal, glass, and rags are major components (Kaza et al., 2018).

Table 1: Five major waste producing countries in 2017 reported by World Bank (2018)

No.	Country	Annual Waste production (metric tons)	Total population	Per capita annual waste production (metric tons)
1.	Canada	1,325,480,289	36.7 million	36.1
2.	Bulgaria	189,141,945	7.00 million	26.7
3.	United States	258 (million tons)	325 million	0.74
4.	Estonia	30,912,409	1.3 million	23.5
5.	Finland	91,698,449	5.5 million	16.6

https://www.investopedia.com/articles/markets-economy/090716/5-countries-produce-most-waste.asp

b) E-waste: E-waste (electrical and electronic) is a rapidly expanding type of waste that is causing a lot of concern. Around 20 to 50 million tons of E-waste was produced globally in 2005. By 2020, the E-waste of used computers in growing nations such as India, South Africa, and Chin would be increased from 200 to 500 % (UNEP, 2010). E-waste contains heavy metals (lead, mercury, and cadmium) which can seep into surroundings and constitute a health risk to humans if not handled properly. There have been several reports of workers from the informal sector involved in disassembling used electronic equipment to collect metals, polymers, and recyclables, frequently without sufficient safety precautions (Bournay, 2006).

c) Industrial solid waste: Industrial waste would include packaging materials, paints, waste from food processing, paper, oils, resins, solvents, glass, sludges, ceramics, stones, plastics, metals, leather, rubber, cloth, wood, abrasives, straw, etc. (Vaccari et al., 2019).

d) Agricultural waste and residues: Naturally, the expansion of agricultural output led to an increase in agro-industrial by-products, agricultural crop waste, and stock waste (Halloran et al., 2014).

e) Hazardous waste: The pulp, paper, and wood processing industries, as well as textiles, oil, leathers, chemicals, metals, petrochemical, and energy facilities, are major sources of hazardous industrial waste. The most harmful waste is a byproduct of a wide range of agricultural, industrial, nuclear, health, medical, and manufacturing operations. Textile, equipment, and automobile repair firms, health care centers, hospitals, metal and electrical processing enterprises, pesticide users, and dry cleaners are examples of small and medium-sized businesses that generate hazardous waste (Chaiyarit et al., 2021).

Waste management

In a broader sense, waste management encompasses every activity linked with the waste management organization, from production to ultimate treatment. Waste management processes comprise of waste collection, transportation, valuation, and disposal (Kaza et al., 2018). The Environmental protection agency act, (Pollution Prevention Act (PPA) of 1990) describes the waste management hierarchy that is represented in figure 1.

Figure 1: Waste management hierarchy (EPA, 2021)

Principles for management of wastes are:

a) Waste hierarchy; refers to the "3Rs rule" Reduce, Reuse and Recycle. Waste minimization and prevention are the most desired goal.

b) Extended producer accountability; adding up all costs from environmental to market price of a product.

c) The polluter pays principle; the waste generator should pay for the cost of suitable disposal of waste (Ferronato et al., 2019).

Different types of waste management

Waste management includes collecting, sorting, processing, recycling, and providing a source of energy and resources when adequately supported. The production and manufacturing of items require a lot of precious energy and resources, which can be challenging to manage. Proper waste management is very important to protect our environment and also there is a need to educate the people and companies themselves about the environment (Saxena et al., 2010).

a) Landfills: Waste disposal in a waste site requires waste burying, which in most countries is still a widespread practice. Landfills in disused or abandoned quarries were regularly built. A well-managed and properly designed landfill can be a clean and comparatively low-cost technique of waste material treatment (Vaccari et al., 2019).

b) Incinerators/combustion: In Incineration or combustion, waste material goes through a heat linked combustion process. It is also called "thermal treatment" as it is a high-temperature waste treatment system. Incinerators transform waste into gas, heat, ash, and steam. Incineration is commonly used in those countries which have rarer land as in incineration method normally not much area is used as in landfills (Chandrappa et al., 2012).

c) Composting: It is the naturally carried out process of organic materials decomposition. Where people have their land organic waste can be dug into humus and fiber (Pearson et al., 2015).

d) Recovering and Recycling: "Recycling" is an environmentally friendly way to manage waste. This approach refers to find out the way to recycle your waste instead of letting it to the landfill (Vaccari et al., 2019).

e) Recovery Energy/Waste to energy (WtE): In this process waste is treated through a series of steps and energy is generated in the form of electricity and heat as an end product. The waste to energy practice comprises of a range of methods that convert non-recyclable garbage into usable heat, power, and fuel. Because non-recyclable garbage may be utilized to create this form of energy, it is a renewable energy source. WtE can also assist reduce carbon emissions by reducing the requirement for fossil-fuel-based electricity. This improves our ecosystem by minimizes global warming over time (Amasuomo and Baird, 2016).

f) Plasma gasification: Other method of waste management is plasma gasification. Plasma is a highly ionized gas. Lighting is a sort of plasma that may reach temperatures above 12,600 degrees Fahrenheit. It is also a thermal process in which organic waste is turned into gases. The molecular bonds in solid waste are broken down during plasma gasification treatment because of great heat and elemental components. Waste and hazardous materials are destroyed as a result of this process. This method provides renewable energy as well as a slew of other advantages (Amasuomo and Baird, 2016).

g) Waste minimization or avoidance: Waste reduction, or the prevention of waste material creation, is an important waste management strategy. Repairing broken items rather than buying new, reusing second-hand products, encourage customers to choose items that are disposable, removal from the cans of any food, Product packaging and design which uses less material for the same purpose, and designing products to be ecofriendly (use of cotton bags as an alternative of plastic) are all examples of this method (Amasuomo and Baird, 2016).

Challenges in waste management

a) Hazard: The first and main challenge in waste management processes is to make sure that consumers and recyclers are both protected from poisonous and hazardous chemicals present in waste (Viljoen et al., 2021).

b) High costs: It can be quite expensive to set up and improve waste collection, recycling, treatment, and disposal systems. Building and managing sanitary landfills and incineration plants, for example, necessitates significant capital expenditures as well as significant running and maintenance costs (Wilson et al., 2010). Furthermore, this cannot be viewed as short term profitable investment because implementing sustainable waste management solutions necessitates a large sum of money (Ziraba et al., 2016).

c) Lack of waste management sites: Because of the prevalence of the Not In My Backyard (NIMBY) mentality among communities, finding acceptable locations for waste treatment plants is becoming increasingly challenging. Meanwhile, if garbage grows at a rate of 3% to 5% per year as well as the rural to urban migration raises the population of cities at the same rate, garbage creation in a city will be twice every ten years (Wilson et al., 2010).

d) Quality of recycled products: Down cycling, the recycling process that converts waste materials into low-quality items, may wreak havoc on the quality of secondary products (https://solarimpulse.com/waste-management-solutions).

e) Conventional Waste Management Consequences: Waste collection, treatment, and disposal are the mainstays of traditional waste management. Only a few attempts have been done to implement practices of integrated-waste-management such as recovery of resources, reducing waste at source, and recycling. Proper separation of waste is necessary at the source to achieve waste resource value (Saxena et al., 2010).

Collection rates in undeveloped countries are still low, and collection services are of poor quality. In impoverished areas, such as slums, waste collection services are almost non-existent. While there are some successful examples of waste management services involving the private sector

and communities. However, in many underdeveloped nations, these groups' participation is still quite restricted. Typically, the waste gathered, ends up in open landfills, where they may be burned, and in some circumstances, disposed at illegal disposal sites (Chandak, 2010).

Benefits of waste management

a) Economic: Waste management takes a lot of steps involving resources and huge consumption of energy, in changing one form of waste to another form. As a result, it has enormous economic potential that both public and private enterprises must tap into (Ziraba et al., 2016).

b) Pollution reduction: Properly managed garbage not only eradicates consequent waste but also lessens the intensity and impact of hazardous green-house gases like CO, CO_2, and CH_4. These gases are recurrently released by the collected waste in the landfills (Amasuomo and Baird, 2016).

c) Job creation: Hundreds of jobs are created by the recycling business alone. Organizations that create and sell recycled products will become more prominent as more individuals adopt this environmentally responsible activity. This helps them grow their business and creates hundreds of jobs (Amasuomo and Baird, 2016).

d) Energy conservation: Recycling as an imperative waste management component helps to preserve energy over time. One of the most visible instances of this advantage is the practice of recycling paper. Thousands of tree are presumably cut down to make paper, as we all know. The requirement for trees to be cut down is greatly reduced when used paper is recycled (Amasuomo and Baird, 2016).

e) Social Impact: Improved waste management not only creates jobs but also improves the quality of life of residents by increasing sanitation and decreasing health hazards related to the inadequate collection of waste and unlawful dumping (https://solarimpulse.com/waste-management-solutions).

f) Better Environment: Sustainable waste management benefits from reducing its environmental effect by enhancing air and water quality and reducing emissions of greenhouse gases (https://solarimpulse.com/waste-management-solutions). Waste disposal systems also help the health of individuals by helping them become disease-free (Amasuomo and Baird, 2016).

CONCLUSION

An increase in waste production due to human activities is the major problem of today's world. Waste management is needed to counter this problem. There are many methods used for waste treatments. Conventional methods (Landfills, composting, etc.) are cost-effective but they are time-consuming, need large areas as dumping sites, and can pollute groundwater by seepage of hazardous materials below the ground. Some new and advanced technologies are also used. However, these technologies also have disadvantages as well as their benefits. One of the most beneficial practices is to minimize the production of waste. Next to this is the energy recovery method that is recommended by the Environmental protection agency. These different methods of waste treatments help in solving the problem of increasing waste volume, reducing the hazardousness of materials present in the waste, help economically by creating jobs and improve the environment. The use of these methods separately has side effects too. So, more focus should be on integrated waste management techniques and energy recovery methods along with focusing on avoidance of waste production.

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