Paradigm Academic Press
Frontiers in Management Science
ISSN 2788-8592
MAR. 2025 VOL.4, NO.2

Waste Management Strategy to Save Environment and Improve Safety of Humanity

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doi:10.56397/FMS.2025.03.05

Abstract

Wastes are defined as the generation of valueless substances that are thrown away after their use that result negative impacts on human health as well as increased pollution of land, air, and water. Some major causes of increased wastes are local and global economic development, urbanization, and improving living standards in cities. Waste management (WM) is a comprehensive type of activities that encompass the collection, handling, transportation, treatment, storage, processing, recycling, and disposal of wastes efficiently. Ineffective and inefficient WM results in greenhouse gas (GHG) and toxic emissions, and the loss of precious materials and resources. It creates an unhealthy and unhygienic living environment, and it is responsible for the spread of diseases, and pollution of lakes and water bodies leading to loss biodiversity. An integrated WM approach is a crucial part for sustainable development strategies and for saving environment, and maintaining proper healthcare. This study takes an attempt to discuss WM policy to reduce the dangerous effects of wastes on the environment and human health.

Keywords: global waste, circular economy, waste management

1. Introduction

Waste is an essential product of human activities and is a part of our everyday life that is increasing dramatically in recently. The high living standards, urbanization, industrialization, increased population, economic development, quick advanced technologies, low cost and design items with a short lifespan, etc. are creating larger quantities of wastes worldwide (Zaman, 2016). On the other hand, waste is directly related to human development, both technologically and socially; some wastes have economic value that can be recycled (Alamgir & Ahsan, 2005).

Waste management (WM) is a lengthy and healthy process that needs collection, transport, treatment, and disposal of waste, together with monitoring and regulation processes through the waste-related laws, technologies, and economic mechanisms (Davidson, 2011). It is one of the major environmental concerns in the world. Proper WM includes waste minimization, waste processing, recycling, waste transformation, and efficient disposal on land. It is one of the hot topics of urban planning and development (Saxena & Joshi, 1996). It is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. Effective WM policy is necessity to implement a circular economy (CE) through the 7R waste practices: refuse, reduce, reuse, repair, repurpose, recover, and recycle (Mohajan, 2020, 2021b).

WM practices are different in developed and developing nations; urban, hilly and rural areas; and residential and industrial producers (Mohajan, 2018). Metropolitan domestic waste is usually managed by the local government authorities; and commercial and industrial wastes are usually managed by the local, national, and international experts (Kaza et al., 2018). Usually there are four possible ways of managing waste, such as open dumping

ground, sanitary landfills, composting, incineration, and plasma technology. Biodegradability in the waste allows it to get absorbed into the soil without affecting the environment that is also suitable for biogas generation through disposal in properly designed sanitary landfills (Eriksen & Astrup, 2019). At present the WM cost is about $325.5 billion and it is estimated that the cost will increase to about $640.3 billion by 2050. At present about half of the world populations are without access to WM services, and most of them live lower- and middle-income countries (Mavropoulos et al., 2012).

2. Literature Review

A literature review is an overview of previously published works, such as scholarly paper, books or articles on a particular topic (Torraco, 2016). It provides the researcher about the general information of an existing knowledge of a research area (Adams et al., 2007). It is a part of a graduate and post-graduate requirement for the preparation of a thesis, dissertation, or a journal article (Bolderston, 2008). Reddy Dhana Raju has stressed on the WM policy to establish a zero-waste based, healthy, hygienic, and sustainable society (Raju, 2021). Constantino Fernandez-Pereira and his coauthors have tried to develop a more sustainable management alternative for an industrial waste produced in increased amounts and provide the basis for a symbiotic coupling relationship among various industrial sectors (Fernandez-Pereira et al., 2024). Chanchai Phonthanukitithaworn and his coworkers have investigated how citizens with characteristics aligned with the CE utilize internal and external knowledge networks to enhance their practices in the 5Rs: repair, reduce, recycle, reuse, and rot within emerging markets (Phonthanukitithaworn et al., 2023).

Phyo Zaw Oo and his coworkers have aimed to assess life cycle GHG emissions from the global municipal solid waste (MSW) management sector for the years 2023, 2030, and 2050; and then analyses the global and regional WM goals set by the UNEP and the EU to identify hotspots in the MSW management systems and critical factors that influence GHG emissions from the waste sector (Oo et al., 2024). Pratap Kumar Swain and his coauthors have presented the status on generation and utilization of both hazardous and non-hazardous solid wastes in India, and their recycling potential and environmental effects are reported and discussed (Swain et al., 2018). Hafez Salleh and his coauthors have proposed a strategy on the adoption of the circular economy principle in the construction and demolition waste sector to improve the performance of the current construction and demolition WM system (Salleh et al., 2022). Mojgan Alighardashi and her coauthors have tried to examine the current healthcare waste (HCW), and consider the local challenges associated with establishing a circular economy (CE) to improve hospital WM (Alighardashi et al., 2024).

Md. Anwarul Abedin and M. Jahiruddin have focused on the status of solid waste generation, WM system, and WM problems in Bangladesh. They have observed that lack of regulations for waste disposal, landfill and use, lack of awareness, improper choice of technology and inadequate financial support are the major constraints for WM in the country. They are hopeful that efforts are underway to improve the system of waste collection, transportation, recycling, incineration and land filling (Abedin & Jahiruddin, 2015). Abdulkadir Kan has presented a detailed review on waste and WM options, and research published on the effect of waste materials on environment (Kan, 2009). Ebikapade Amasuomo and Jim Baird have shown that the effectively planning ahead will prevent indiscriminate disposal and other harmful practices so as to prevent the build-up of open dumps and breeding ground for rats and other vermin which poses health risk (Amasuomo & Baird, 2016). Samuel Fosso Wamba and his coauthors have stated that plastic WM represents a fundamental challenge in terms of environmental pollution and health in many emerging countries. Their findings suggest that plastic WM for value creation is still embryonic in Cameroon (Wamba et al., 2023).

3. Research Methodology of the Study

Research is a systematic gathering of data and information, and it is an analysis for the advancement of knowledge in any subject that attempts to find answer intellectual and practical questions through application of systematic methods (Kara, 2015). It is an original contribution to the existing stock of knowledge making for its advancement. Methodology is the study of research methods that is traditionally divided into quantitative and qualitative research. Therefore, research methodology is a way of explaining how a researcher intends to carry out research (Bryman, 2008).

4. Objective of the Study

Waste is defined as discarded materials that have no value in normal use. It may be organic and inorganic; hazardous and non-hazardous; and solid, liquid, and gaseous materials that are unwanted by its user and most of them are recyclable (Velenturf & Purnell, 2017). It is created in homes, hospitals, factories, farms, schools and colleges, mines, construction sites, and picnic spots. WM is the processes of dealing with waste at every stage from generation and collection through to final disposal (Mohajan, 2021a). Main objective of this article is to examine proper WM. Other subsidiary objectives of the study are as follows:

1) to specify waste and its types,

2) to stress on management of waste, and

3) to show the importance of waste management.

5. Waste

According to the Basel Convention, wastes are all useless items, such as household rubbish, sewage sludge, wastes from manufacturing activities, packaging items, discarded cars, old televisions, garden waste, old paint containers, etc. that people no longer have any use for, which they either intend to get rid of or have already discarded, and are disposed by the provisions of national laws because of their hazardous properties (UNEP, 2021). Waste can either be solid, liquid, and gasses; and each type has its own method of disposal and management. The solid waste is generated by domestic households, commercial land industrial enterprises, mining, municipality, agricultural operations, and healthcare and institutional activities, as well as on the streets and public places by the general population (Wilson et al., 2015).

Usually, the developed countries generate more wastes than developing countries (Mohajan, 2021c). For example, Asian and African countries produce waste in the range of 0.21-0.37 tons/capita/year, while European countries generate higher amount of waste with 0.38-0.64 tons/capita/year (IPCC, 2006). At present the world generates about 2.3 billion tons of waste annually, and this is expected to increase 70% to reach 3.5 billion tons annually by 2050 (Raju, 2021).

The increase of waste is due to overpopulation, affluence, and technological advancement. In 2019, about 96 billion tons of primary materials were extracted and consumed globally, but only 9% were recycled (UNEP, 2024). After the adoption of a circular economy the world has yield significant economic benefits, and it is estimated to reach a value of $4.5 trillion by the year 2030. Waste is usually managed in four stages, such as generation, collection, segregation, and treatment. In landfills, wastes remain for a longer time and degrade the environment with breeding of mosquito, rodents, fly, etc. which pollutes the land, water, and air (Sharholy et al., 2008).

6. Types of Waste

Wastes are of various types and differently classified, based on specific parameters and depending on the origin and type, such as physical states, physical properties, reusable potentials, biodegradable potentials, source of production, and the degree of environmental impact (Demirbas, 2011). These are seen in three forms, such as solid waste, liquid waste, and gaseous waste. These can be classified mainly in two types: hazardous waste and non-hazardous waste (Sandhu et al., 2017).

Hazardous waste has physical, chemical, or biological characteristics and requires special handling and disposal procedures to avoid negative health effects, adverse environmental effects or both. Characteristics of these wastes are toxic, oxidizing, explosive, flammable, irritant, corrosive, carcinogenic, infectious, and mutagenic (Wilson et al., 2015). Non-hazardous wastes do not have intrinsically dangerous or toxic properties. For example, paper, plastic, wood, lime sludge, metal scrap, glass, and organic wastes are non-hazardous wastes. These wastes can be is either recycled and reused, or treated and disposed (Hoornweg & Bhada-Tata, 2012). There are many types of wastes, such as household, industrial, biological, municipal, organic, biomedical, and radioactive (Giusti, 2009).

6.1 Industrial Waste

Industries wastes are different waste flows that are derived from a variety of industrial processes. Industries produce both hazardous and non-hazardous liquid and solid wastes that are generated during the manufacturing process which turns raw materials into consumer products (Hao, 2013). These are disposed of in an unscientific manner on open plots or on the roadside, and create environmental pollution. These wastes are chemical, petroleum, coal, metal gas, sanitary paper; paper and paper products; wood and wood products, etc. (Shafigh et al., 2014). But very few sites are authorized for the disposal of industrial waste in the country. Consequently, industrial solid wastes are disposed of in an unscientific manner, and create environmental pollution and subsoil contamination (Islam et al., 2013).

6.2 Construction Waste

Construction and demolition wastes are generated during the course of repair, remodeling, renovation, maintenance, and construction activities of various infrastructures, such as buildings, roads, bridges, dams, tunnels, railways, and airports (Hemalatha et al., 2008). Materials subject to this category are bricks and masonry, sand, gravel, bitumen, asbestos, stones, tiles, cement concrete, paint, timber, iron, steel, copper, wood, and so forth that are generally not stored by the waste generator within its premises until disposal (Akanbi et al., 2018). These wastes are deposited just outside the premises on the streets or in open spaces and may hinder traffic and adversely affect the aesthetics of the city. Construction provides job facilities and associated with economic development, but it is the major cause of environmental pollution (Menegaki & Damigos, 2018). The huge

volume of solid waste generated by the construction industry that results the limited availability of land in the country (Poon et al., 2001).

6.3 E-Waste

E-waste is any electrical or electronic equipment that has been discarded. It is also known as waste electrical and electronic equipment (WEEE) or end-of-life (EOL) electronics (Kahhat et al., 2008). It is being created by a variety of sources, such as government and non-government sectors, education and laboratory sectors, research and development sectors, medical and clinical sectors, household and manufacturing sectors, etc. (Tale, 2020). It consists of end of life discarded, surplus, obsolete, broken, electrical or electronic devices that comprises of a range of electrical and electronic items, such as computers and printers, electrical and electronic tools, washing machines, medical equipment, refrigerators, televisions, etc. (Agnihotri et al., 2011). Potentially various harmful materials in e-wastes are lead, cadmium, mercury, beryllium, brominated flame retardants, polychlorinated biphenyls (PCBs), arsenic, etc. (Osibanjo, 2007; Mohajan, 2024). E-waste that barely existed before was generated as much as 20-50 metric tons a year (UNEP, 2006).

6.4 Biomedical Waste

Biomedical wastes are generated in hospitals, research institutions, healthcare teaching institutes, clinics, laboratories, blood banks, animal houses, and veterinary institutes (Pasupathi et al., 2011). These are solids and liquids, such as discarded drugs, containers, waste sharps, microbiological and biotechnological waste, human anatomical waste, contaminated animal waste, pathological waste, etc. that are heavily infectious and toxic, and generated during the diagnosis, testing, treatment, and research (Brunner & Rechberger, 2014). About 85% of hospital waste is non-hazardous, 10% is infectious, and the rest 5% is non-infectious. Proper management of biomedical waste is highly essential, because it creates various risks to the human health and to the surrounding ecosystem due to the ecological hazard, professional hazard, and public hazard (Kalpana, 2016). Biomedical wastes must be disinfected before disposal, syringes to be cut with hub cutters and anatomical wastes must be disposed by deep burial (Yazie et al., 2019).

6.5 Radioactive Waste

Waste that contains a concentration of radio nuclides greater than those deemed safe by national authorities is considered as radioactive that takes million years to decay. Usually these are byproducts of nuclear processes and are generated from nuclear power plants, nuclear testing lab, and industrial establishment (Swain et al., 2018). Some of these wastes remain radioactive for hundreds or thousands of years, while others may require storage for only a short period, while they decay, prior to conventional disposal (Abdel-Karim et al., 2019). Sometimes industries that are not directly involved in nuclear activities may also produce some radioactive wastes, such as radio-isotopes, chemical sludge, etc. (Deng et al., 2020).

6.6 Mining Waste

Mine wastes are unwanted, currently uneconomic, solid and liquid materials found at or near mine sites. These are arising from prospecting, extraction, treatment and storage of minerals, processing of ore, waste rock, and overburden (Ochieng et al., 2010). The major sources of mining waste are tailings, dumping leaches mine water seepage, and other process wastes disposed of the mine (Ostrega et al., 2024).

6.7 Municipal Waste

Municipal wastes are household and commercial that are generally generated by households and commercial activities. These are generated by household garbage, rubbish, construction and demolition debris, sanitation residues, cardboard, metals, used paper and plastic, packaging materials, textiles, organic waste, trade refuges, etc. that are managed by the municipality (Mor et al., 2006). Of these wastes 54% is discarded, 35% is recycled, and the rest 11% is incinerated. Plastics, packaging materials, and other synthetic materials that last longer are increasing due to urbanization and industrialization (Idris et al., 2004).

7. Impact of Waste

Wastes adversely affect the air, water, and soil until their complete decomposition. Improper WM has negative effects on both the quality of environment and human health. All wastes are threats to the environment and human health if not handled appropriately (Bello et al., 2022). Proper management of wastes is necessary for the welfare of environment and human health. Different wastes and WM activities have varying impacts on energy consumption, methane emissions, carbon storage, ecological and human health (Wilson, 2007).

7.1 Impact on Health

Soil contamination with wastes can harm plants through their roots that can adversely impact the health of humans and animals. Improperly managed of landfills can spread insects that develop various diseases, such as dysentery, diarrhea etc., which affect the health of human beings. Emissions from incinerators and landfills can

cause air pollution that emit dioxins, furans and polychlorinated by-phenyls (PCB), which are deadly toxins and can cause cancer, lung cancer, heart disease, cholera, hepatitis, and endocrine system damage. Scientific evidences show that people who live near the landfills have a high risk of low birth weight, birth defect, symptoms of fatigue, headache, and some types of cancer (Giusti, 2009).

7.2 Impact on Environment

Animal wastes, farming wastes, horticulture wastes, and domestic waste degrades the environment that increases concentration of ammonia and methane in atmosphere, which causes acidification and global warming (Shafigh et al., 2014). Household hazardous wastes are old batteries, shoe polishes, paint tins, old medicines, and medicine bottles that carry contaminated chemical are toxic to humans, animals and plants (Vergara & Tchobanoglous, 2012). Contamination of water with wastes can affect all levels of an ecosystem. Wastes can emit greenhouse gases (GHGs) that can cause global warming. The waste sector is a major anthropogenic source of about 5% global GHG emissions (IPCC, 2006).

8. Management of Waste

Sustainable WM is an environmentally sound and socially satisfactory that is achieved through strategic planning, institutional capacity building, fiscal incentives, techno-economically viable technologies, public-private partnerships and community participation (TERI-BCSD, 2014). At present only 40% of EU household waste is recycled. Improper waste disposal may cause pollution that is a threat to human and other living organisms. It may damage the ecosystem and disrupt the natural cycle and climate on earth (Ebikapade & Baird, 2016). Waste management indicates the prevention, minimization, reuse, recycling, energy recovery, and efficient disposal of wastes. At present SWM becomes a great challenge in environmental issues where population is rapidly growing and amount of waste generated is increasing very rapidly (Mazzanti & Zoboli, 2008).

9. Importance of Waste Management

Proper WM practices, such as recycling, incineration, and controlled landfilling can help to mitigate environmental pollution and minimize health hazards. Effective and efficient WM is vital for preserving public health that prevents the spread of diseases, protects the environment, controls disease vectors, ensures occupational safety, and promotes the well-being of communities (Ragaert et al., 2017). Proper waste collection, storage, transportation, treatment, and disposal can prevent the spread of infectious diseases. For example, biomedical WM can protect bacteria, viruses, and parasites. Adequate WM can decrease disease-carrying vectors, such as flies, rodents, and mosquitoes that thrive in waste and spread various diseases, such as dengue fever, malaria, and cholera (Wilson et al., 2015).

When efficient WM practices are introduced into production and consumption, valuable materials are recovered, and people find jobs and economy will develop, consequently poverty and health problems will reduce (Abedin & Jahiruddin, 2015; Mohajan, 2015). To implement proper WM atmosphere we need adequate training, proper handling techniques and the use of PPE are crucial (Marchettini et al., 2007). Clean and hygienic surroundings promote a healthier living environment. By creating clean and hygienic surroundings through the proper WM we can create healthier and safer living environments for everyone through the proper WM. Moreover, the WM practices promote sustainability, reduce carbon footprint, and conserve natural resources through the recycling and resource conservation (Vergara & Tchobanoglous, 2012).

10. Conclusions

At present both hazardous and non-hazardous wastes are increasing due to globalization, unsustainable economic growth, unplanned urbanization and industrialization. These wastes pose potential impact on mixture of different kinds of dangerous constituents, such as toxic radioactive substances, methane gas, pathogens, industrial effluents, and medical, pathological and harmful chemicals that can pose a threat to human health, other living organisms, and environment. Waste recycling is an important factor that helps to reduce the demand on resources and the amount of waste requiring disposal by landfilling. WM as an industry that aims to present a zero-waste based healthy, hygienic and sustainable society; provides an employment opportunity of many workers, and provides an alternative source of natural resources for the prosperity and wellbeing of the global humanity. Public awareness and education on proper WM are necessary to establish a hygienic, and a sustainable healthy society.

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