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Environmental and Health Impacts of Increased Municipal Solid Waste: A Sustainable Management Practice

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Abstract

The municipal solid wastes (MSWs) are generated by the household, institutional and commercial, street, demolition, and industrial sources of the municipality. These wastes are identified as biodegradables, non-biodegradables, recyclables, and inert materials. These are increasing rapidly due to rapid urbanization, increased industrialization, improvement of living standards, rapid economic growth and development, population growth that result in environmental contamination, and the increase of numbers of landfills. At present MSW is the most alarming issue for safety, health, and environment that poses a significant threat to both the global economy and ecosystems. Proper management of MSW is economically and environmentally crucial for the sustainable development. On the other hand, improper management of MSW can have a significant impact on human health and the environment. At present the proper MSW technologies are developed that not only reducing the waste significantly, but also generating substantial quantity of decentralized energy. This study examines the techniques of MSW management and the consequence on the health of the city dwellers.

Keywords: municipal waste, recovery, recycling, landfill, incineration

1. Introduction

Various anthropogenic activities actively produce various kinds of waste that have existed since the start of human civilization. Waste is the most often defined by its source, such as household waste, industrial waste, construction and demolition waste, and electronic or medical waste (Wilson et al., 2012; Mohajan, 2015). In recent years, the municipal solid waste (MSW) creates a great problem due to the increase in population as a result of industrial development in major towns and cities of the world that have necessitated rapid growth of urbanization (Adejobi & Olorunnimbe, 2012). These wastes are categories as, food waste, paper, plastics, wood residue, textiles, glass, aluminum can, sludge, and steels and other metal scraps (Mohajan, 2020). Most cities of the world are facing waste problems due to the rapid increase of MSW amount and the limitations of the MSW management system (Phu et al., 2021). It is estimated that global waste generation in low, lower-middle, upper-middle, and high-income countries are about 5%, 29%, 32%, and 34%, respectively (Maalouf & Mavropoulos, 2023). The cost of MSW management activities in developed countries with advanced waste treatment systems is about $350 per ton, and the corresponding figures are $20 and $100 per ton in low and middle-income countries, respectively (Kumar et al., 2016).

About 2.01 billion tons of municipal solid wastes (MSWs) from residential, commercial, and institutional sources are generated globally, and it is estimated that this figure will develop to 4 billion tons by 2050 (Mohajan, 2018). These result in diseases, explosive gases, air pollution, landfill gas and liquid migration, and water and marine pollution (WHO, 2024). In the USA, the MSW is known as trash or garbage, and rubbish in Britain. Rapid urbanization and population growth are mainly responsible for very high increasing rate of MSW generation in the urban areas that possess a social, environmental and professional threat for city dwellers, urban

planners, development authorities, and other concerned stakeholders (Alamgir & Ahsan, 2007).

Management of MSW is one of the most important functions in city administrations. It is a key service on which public health, the maintenance of safe public spaces, the implementation of environmental policies, and the external image of the city depend (Luz et al., 2021). All the municipalities worldwide are under heavy pressure to implement more efficient technologies and policies to manage MSW, and to reduce environmental threats. At present MSW management practicing are waste recycling, biological treatment, and energy recovery (Young, 2010).

2. Literature Review

A literature review is an overview of previously published works on a particular topic that is included for the preparation of a dissertation, research proposal, prospectus, and a journal article (Baglione, 2012). It deals with the secondary sources and does not report new or original experimental work (Galvan, 2015). A good literature review has a proper research question, a proper theoretical framework, and a chosen research methodology (Cooper, 1998). Chris Zurbrügg and Roland Schertenleib have identified five major problems of SWM in developing countries and have provided the probable solutions for improving the situation through the emphasis on the problem of inadequate landfill disposal (Zurbrügg & Schertenleib, 1998). Muhammed Alamgir and Amimul Ahsan have aimed to evaluate the per capita generation, total daily generation, percent composition and the potential for waste recovery and reduction through the different waste generation sources, such as residential, commercial, institutional and open areas at six major cities, namely, Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet of Bangladesh (Alamgir & Ahsan, 2007).

Seshibe S. Makgato has wanted to quantify and analyze the composition of MSWs by type, evaluate proximate and ultimate analysis, and assess the potential effectiveness of energy generation. His study findings try to select and design the thermal waste-to-energy process for the composition of the studied waste, thereby expediting the transition to a circular economy in urban regions and reducing pollution (Makgato, 2024). Ityona Amber and his coworkers have studied the generation, characteristics, and energy potential of MSW for power generation in Nigeria where waste is managed poorly, such as direct burning that elevates temperatures liberates heat energy, inert gases and ash, which can be conveniently used for power generation and other applications (Amber et al., 2012).

Omotayo Sarafadeen Amuda and his coworkers have provided an overview of the state of MSW management by local authorities in Nigeria. They have realized that the unplanned urbanization growth will definitely lead to huge problems on governments, especially for meeting the increasing demand for proper and healthy municipal services (Amuda et al., 2014). Mohammad Rasel Kabir has shown that generation of MSW is threateningly increasing due to the rapid growth of population, urbanization, industrialization, and improved living standards with the increasing scale of economic activity. He has tried to evaluate the capacity of Dhaka City Corporations in handling waste against the mounting generation of MSW (Kabir, 2015). Anees Ahmad and his coworkers have wanted to examine the advanced environmental and techno-economic performances of sustainable bio-fertilizer production from mixed MSW using a life cycle assessment (LCA) approach (Ahmad et al., 2025).

3. Research Methodology of the Study

Research is a process of steps used to collect and analyze information to increase our understanding of a topic or issue. It is a systematic investigation and study of a specific topic to discover new knowledge (Creswell, 2008). It involves the collection, organization, and analysis of evidence to increase understanding of a topic, characterized by a particular attentiveness for controlling sources of bias and error (Kara, 2012). Methodology is the systematic method to resolve a research problem through data gathering using various techniques, providing an interpretation of data gathered, and drawing conclusions about the research data (Murthy & Bhojanna, 2009).

Research methodology is a structured and scientific approach used to collect, analyze, and interpret quantitative or qualitative data to answer research questions or test hypotheses. It refers to both the specific procedures used in research and the broader philosophical discussions about the underlying assumptions and values that guide these procedures (Groh, 2018). It includes all the important aspects of research, such as research design, data collection methods, data analysis methods, and the overall framework within which the research is conducted. It describes the techniques and procedures used to identify and analyze information regarding a specific research topic. There are three types of research methodology, such as quantitative, qualitative, and mixed-method (Cohen & Arieli, 2011).

4. Objective of the Study

The volume of MSW is generated in a city due to human activities, such as population growth, urbanization and social development, resources exploitation, and unchecked technological advancement (Amuda et al., 2014). When the population is increased in the cities, the concentration of industrial, commercial, infrastructural, administration, and government activities are also increased (Mohajan, 2021a). Main objective of this article is

to increase the efficiency of MSW management and establish a sustainable way to generate energy, and reduce the dependency on fossil fuels that causes harm to environment, eco-system, and human beings (Henry et al., 2005). Other minor objectives of the study are as follows:

1) to highlight on mechanisms and effects of MSW,
2) to focus on MSW management policy, and
3) to discuss health and safety of MSW management workers.

5. Mechanisms of MSW

Raw materials from natural resources are limited, financial resources are often insufficient, and securing land for final disposal is getting more difficult (Mohajan, 2025h). All the cities of the world should provide a clean, healthy and pleasant living environment to its citizens for current and future generations (Mohajan, 2021b). There are three types of MSWs: i) degradable wastes, such as paper, textiles, food waste, straw and yard waste, ii) partially degradable wastes, such as wood, disposable napkins and sludge, sanitary residues, and iii) non-degradable wastes, such as leather, plastics, rubbers, metals, glass, ash from fuel burning like coal, briquettes or woods, and dust and electronic waste (Herat, 2009).

Rapid growth of population in cities is increasing the rate of waste generation that increase air pollution during burning wastes, and is increasing concentration of greenhouse gases that cause global warming (Amuda et al., 2014). Usually, the developing countries face five types of problems during MSW management, such as i) inadequate service coverage, ii) operational inefficiencies of services, iii) limited utilization of recycling activities, iv) inadequate management of non-industrial hazardous waste, and v) inadequate landfill disposal (Zurbrügg & Schertenleib, 1998). The MSW industry has four mechanisms, such as source reduction and reuse, recycling, incineration, and disposal. All of these are necessary for the proper management of MSW (Goodarzian et al., 2022).

6. Effects of MSW

Environment is the sum of all social, biological, physical, and chemical factors that compose the surrounding of human being (Iqbal et al., 2015). MSW created many negative effects on environment, such as air pollution, land pollution, groundwater contamination, and social conflict in the waste disposal area that attributes negative impact on real estate values, loss of available resources, such as loss of cultivated land, and environmental degradation, such as traffic congestion generated by waste disposal vehicles, and facilities unpleasant odor, pests, dust, noise, etc. (Hasnat et al., 2019). Infectious chemicals and radioactive hazards can be created by medical wastes on handling and disposal due to improper dumping that may cause various fatal diseases, such as cancer (Mohajan, 2025g). Bad odor can be created by degraded waste materials while transporting, handling, and dumping into landfills. Blockage of drainage and river system by MSW may cause flood in rainy seasons (Iqbal et al., 2015). These also increase the risk of human health that leads to the disruption of normal life. For example, methane gas emissions from landfills contribute to 4% of global greenhouse gas emissions, while the uncontrolled disposal of waste in oceans poses a grave threat to marine life (Lu et al., 2017). The MSW produces enormous amounts of methane that can be used in industry and household matters (Hoy et al., 2023).

7. MSW Management Policy

Operating system of MSWs management is a complex chain of interdependent logistical processes that includes waste prevention, generation, storage, collection, transportation, processing, resource recovery, recycling and reuse, treatment, and disposal (Kumari et al., 2019). MSW directly generates carbon dioxide, methane, nitrous oxide, and other harmful substances that can damage the environment. Effective MSW management has an important preventive impact that contributes to public safety, and the prevention of environmental damage and contamination (Okedere et al., 2019).

Usually MSWs are needed to handle, store, collect, and disposal, but the whole process can pose risks to the environment and to public health (Mohajan, 2025f). If these are not properly managed, insects are developed in wastes, pollute water resources and air, and various diseases are spread by the vectors, and the greenhouse gas emissions can impact on climate change (Zurbrügg & Schertenleib, 1998).

Modern MSW management policy is to provide top priority on reduction and then follow by utilization, incineration, burying, and landfill of the municipal waste (Sandhi & Rosenlund, 2024). It plays an essential role in maintaining the environment as well as the hygiene of the inhabitants, and that has been considered as one of the major contemporary concerns for urban management (Bassi et al., 2017).

7.1 Recycling

Recycling is a critical component of the circular economy, as it involves processing used materials to create new products, thereby conserving natural resources and reducing energy consumption associated with raw material

extraction. It can enhance resource efficiency, minimize environmental impacts, and promote sustainable urban development (Indriawati et al., 2024). The MSW is a raw material and energy source that can be recovered (Mohajan, 2021c). More than 50% of the waste collected worldwide is often disposed through uncontrolled landfilling and about 30% is processed through unsafe and informal recycling and the remaining 20% is incinerated (Chandak, 2010). Therefore, about 70% of MSW is not recycled that represents a significant loss of valuable supplies, placing a substantial strain on primary resources that exert detrimental effects on both the environment and socio-economic structures (Lu et al., 2017).

Recycling has environmental benefits at every stage in the life cycle of MSW, such as significant economic, job creation, and reduction of global warming (Edet & Maduabuchi, 2019). Potential recycling is necessary to improve MSW management activities and reduce waste generation. The ultimate benefits from recycling of MSW are cleaner land, air, and water; overall better health; and a more sustainable economy (Mohajan, 2025e).

7.2 Disposal

The disposal of MSW by land filling is the ultimate fate of all solid wastes. The aim of solid waste disposal is to immediately remove solid waste from urban community and reduce its volume in hygienic ways (Kamaruddin et al., 2017). Cost effective environmentally acceptable disposal methods of MSW is necessary to reduce pollution and global warming, keep the human habitats ranging from small towns to big cities clean and green, recover 'resources' which can be recycled into useful products for reuse, and process of wastes into useful clean energy, such as heat and electric power (Reddy, 2011). Therefore, it is important to take into account the type, form, composition of wastes, location of landfill site, regional, hydrological, and climatic condition before disposal of MSW (Johari et al., 2014).

8. Health and Safety of MSW Management Workers

The MSW management service is one of the most dangerous professions, and waste workers are particularly exposed to potentially severe occupational health and safety risks (Mohajan, 2025d). The most common forms of injuries the MSW workers often face are respiratory illnesses, back and joint injuries, infections, puncture wounds, various injuries, headaches, nausea, and heavy metal poisoning (Philips & Thorne, 2013). Some of the major problems the MSW workers face are, cut and wound by broken glasses, blades, syringes, nails, and thorns; poisoning from hazardous substances and heavy metals, such as lead, mercury, cadmium, pesticides, paint, e-waste, etc. (Mohajan, 2025c); injuries from dogs, rats, snakes and poisonous insect bites; stress due to heavy workload and tight shifts; traffic accidents at points of collection, waste transfer points, and final disposal; back pain and repetitive strain injury due to over workload; and biological contamination from medical wastes (Sandu et al., 2017).

The MSW workers are vulnerable to diseases that are carried by vectors, such as rats, mosquitos, flies, cockroaches, pigs, and birds (Mohajan, 2025a). Workers can be exposed to toxic substances which can affect the vital organs of the body and cause major health conditions, such as immune problems; cancers; damage to the reproductive system and birth defects; respiratory and lung diseases; liver problems; neurological and kidney problems (Philips & Thorne, 2013). They can be infected with HIV/AIDS due to handling of hospital waste, tetanus due to handling of jagged metals, respiratory problems due to exposure to smoke, and neural damage due to exposure of lead (Mohajan, 2025b). The life expectancy may reduce if they workers are not properly trained, no protection materials are equipped, and proper treatment is not provided to recover from ill-health and injuries (Samson, 2015).

9. Conclusions

MSW management is one of the major challenges for every municipal authority worldwide and is considered as an obvious result of human activities. This is the most alarming issue for safety, health, and environment. At present it has become both local and global phenomenon. Rapid urbanization, poor waste management system, lack of technical experiences and financial resources, and lack of coordination among proper plans, skilled manpower, and public awareness are the major challenges for managing the MSW. MSW is increasing very rapidly, therefore, it is needed to improve the efficiency of resource use, and organize the processing of MSW to maximize the use of their material and energy potential. Development of reduce, reuse, recycling activities are necessary and increase the level of environmental awareness among common people should be encouraged that will result in a smaller waste stream to landfill. All nations should be come forward that the waste materials can be turned into wealth that will reduce the need for increasing extraction of raw materials and fossil fuels.

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