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Socio-Economic Impact of Municipal Solid Waste Management Strategies &Practices for Protecting the Environment: A Review

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Abstract

Developed and developing nations alike have a formidable challenge in managing municipal solid waste due to the vast amounts of garbage produced by homes and businesses in both urban and rural regions. Increased urbanization and changes in living patterns contribute to environmental degradation, as shown in the current scenario, by increasing amounts of municipal solid garbage. Awunyo et al. (2013) found that although generators or producers of hazardous commercial and industrial waste are usually liable for its management, local government authorities in some metropolitan areas are tasked with handling non-hazardous residential and institutional waste.The world is currently facing a critical situation in terms of industrial waste and municipal garbage management, especially in less developed nations (Kamara, 2011).

As a result of urbanization, one of the world's most pressing concerns is the accumulation of waste and the scientific management of that waste. According to a 2012 study by the World Bank, annual global trash production is more than 1.3 billion tons, and by 2025, experts anticipate that figure will have increased to 2.2 billion tons. In East and South Asia, which includes India, 33% of the world's trash is produced. The majority of East Asia's 270 million tons of garbage per year comes from China. Approximately 62 million tons of trash are produced in sub-Saharan Africa each year, whereas over 93 million tons are generated in Eastern and Central Asia. With an annual output of 572 million tons of solid garbage, the OCED countries are responsible for approximately half of the world's waste. In addition to aesthetic and health problems, the garbage problem has highlighted other ecological imbalances and hazards (Coelho et al. 2012).

Keywords: Municipal Solid Waste Management, urbanization, hazardous, commercial, industrial, residential, health, environment.

Introduction

The issue of waste management has become a financial burden for municipalities, as well as a source of ignorance regarding the complexity and multidimensional nature of the approaches needed to address it (Guerrero et al., 2012). Municipalities nowadays require the assistance of other organizations, associations, and individuals in order to manage trash since they cannot function alone.At times, local governments can be a great resource for motivating communities to take up garbage management. In these kinds of interactions, the municipalities can offer the facilities, equipment, financial resources, infrastructure, composting sites, and other amenities that the inhabitants require (Anschütz 1996).

From garbage generation to final disposal, waste management involves numerous steps, from which components of the economy, society, politics, law, environment, and social networks emerge. The amount of waste produced, the manner in which it is disposed of, and the patterns of different materials that society uses all influence the social aspects of MSWM. The primary purpose is to

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restate the social interest in waste minimization and reduction as well as the extent of waste type segregation.

The degree to which the relevant authorities collect and dispose of waste depends on the attitudes of the public. By integrating community-based collecting systems with the municipal system, attention should be drawn to the involvement of individuals as well as the activities of relevant governmental bodies. It is also possible to raise a great deal of public knowledge through broadly designed programs that address environmental and public health issues (Schübeler, 1996). Aside from the municipal authorities, stakeholders that are important in trash management include homes, micro and small businesses, NGOs, rubbish pickers, itinerant waste purchasers, and community-based groups (Muller and Hoffman, 2001).

Environmental and Socio-economic Burden of Total Waste Generated

The full life cycle of materials and products must be taken into account in any discussion on the overall amount of waste that is produced. Wilson et al. (2013) list the following as examples:

1. Extraction-related wastes from mining and quarrying;
2. Agricultural and forestry-related wastes;
3. Industrial wastes (materials, parts, and product manufacturing);
4. C&D wastes;
5. C&I (distribution and services) wastes;
6. Domestic consumption;
7. Municipal solid waste

In Russia, for instance, construction and demolition accounted for 93.6% of all waste in 2019, whereas municipal solid waste (MSW) constituted just 0.8% of the whole garbage (Maalouf et al., 2021).

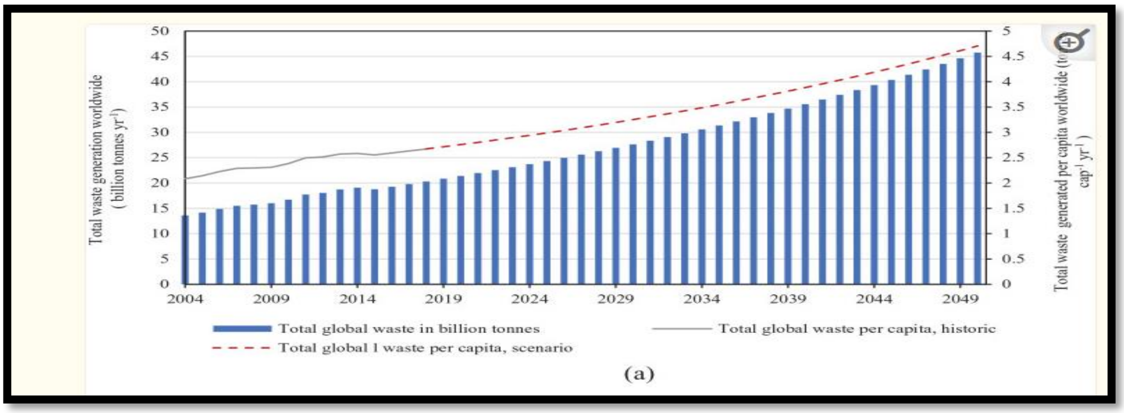

Figure 1: Projections of Global Waste Generation per Capita to 1950 estimated total amount of garbage produced globally. (a) Total amount of garbage generated globally between 2004 and 2050. (b) The estimated global garbage creation total between 2017 and 2050.

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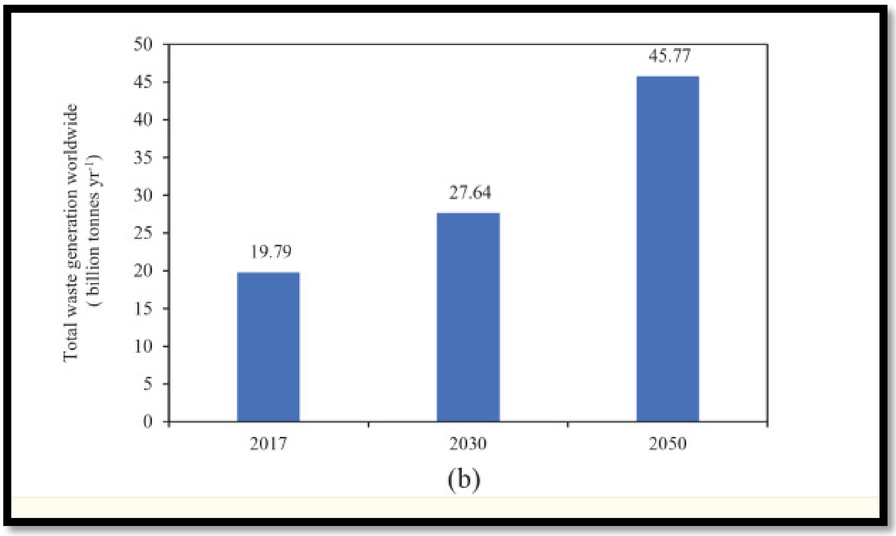

Figure 2: Total Waste Generated per Capita Projected Growth [2017 to 2050]

On one side, we can see the predicted annual global waste output in billion metric tons, and on the other, we can see it in tons per capita. Data collected between 2004 and 2017, together with outcomes for the years 2018 through 2050. Estimates for 2030 and 2050 were derived from this predicted total amount of trash created worldwide, which was derived from a compilation of global material extraction (DE) figures from UNEP (2021) and Krausmann et al. (2018).

From 2004–2019, all of the models indicated that MSW generation will rise. The MFA prediction models run the gamut from 11% (the lowest projection) to 15% (the highest forecast), with Waste Atlas, GWMO, and the World Bank among them. Predictions produced by the Waste Atlas and the GWMO models are very similar.

Leakage from improper disposal, open burning in homes and dumpsites, and marine litter would cause the real amount of MSW to be far higher, even if 2019 MSW production was 2.7 billion tons.

Estimated Municipal Solid Waste Production Up to 2050

New 2019 baseline data were used to make MSG generation predictions for the year 2050. We compared two potential futures to determine the rates of municipal solid waste generation from 2019 to 2050. First scenario (S1) 2050 assumes no change in MSW generation per capita from 2019 levels. The method we used was to multiply the per capita waste generation rate in 2019 by the expected population level in 2050. One alternative, S2 2050, projects that MSW generation per capita will rise by 15% in 2019. The next step was to multiply the 2019 adjusted per capita trash generation rate by the estimated 2050 population level.

The Present State of MSW Management on a Global Scale in 2003

Our analysis of the present state of MSW management on a worldwide scale is based on the aforementioned waste volume, which was 2.7 billion tonnes in 2019. We sourced the data set for this waste flow assessment from the most recent World Bank report (Kaza et al., 2018). Wiedinmyer et al. (2014) established conclusions regarding open burning, while Maalouf et al. (2020a) examined the extra waste management infrastructure that was delivered from 2016 to 2019. The numbers for uncollected garbage, dumpsites, and open burning were revised in accordance with the projected volume of MSW for 2019. It was demonstrated in a newly published South African study (Rodseth et al., 2020) that 2.9% (3.67 million tonnes year−1) of municipal solid waste is not collected. According to Kaza et al.

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(2018), this finding is concerning because it represents an increase of 370 million metric tons from the World Bank's 2017 estimate. Comparing countries' collection coverage reveals significant differences, according to data from the World Bank (Kaza et al., 2018). In nations with high incomes, the national average percentage is over 96%, while in countries with low incomes, it is around 40%. These numbers do not factor in the quantities of MSW that are publicly burned, which is a problem in areas with low incomes and rural areas. Consequently, uncollected MSW, open burning, and dumping in uncontrolled dumpsites are common but underappreciated practices.

South Asia (75%), the Middle East and North Africa (MENA) area (52.7%), and the World Bank (69%) all have high rates of unauthorised disposal (Kaza et al., 2018). The International Solid Waste Association (ISWA)'s Mavropoulos (2015) says that dumps handle about 40% of the world's trash and serve 3.5 to 4 billion people. 64 million people, or half of France's population, get their daily food from the 50 biggest dumpsites. There will probably be hundreds of millions more people to put in dumps as towns and populations grow, especially in developing countries.

Potential Dangers of Unregulated Landfill Disposal of City Solid Waste

Careless disposal is bad for both people's health and the earth. 373 dumpsites in the Philippines, Indonesia, and India were found to have industrial and toxic waste contaminants, such as lead and hexavalent chromium. This put 8.7 million people at high risk of exposure in 2010 (Chatham-Stephens et al., 2013). A new study (Tearfund et al., 2019) found that bad solid waste handling kills between 0.4 and 1 million people every year around the world. Uncontrolled burning of trash in neighbourhoods and dumps kills about 270,000 adults too soon every year (Kodros et al., 2016). Mavropoulos et al. (2016) say that the ISWA has recorded 750 deaths in less than a year that are directly linked to health problems caused by bad waste management at dumpsites and other problems. There have been many reports that have looked at the data, mostly for dumpsites, to try to make people aware of how bad these places are for their health. Three of them—Mavropoulos (2015) and ISWA (2016)—built on work done by D-Waste (2013), which listed the fifty biggest dumpsites in the world. After reading more than 3,000 papers from 22 different countries, Maalouf et al. (2020b) clearly show that land disposal puts people's health and safety at an unreasonable risk. As a result, we need to start closing down and making dumpsites less dangerous right away to protect some of the poorest people in the world.

Fascinatingly, the following highlights two important points:
1. First, the amount of waste collected by the unorganized sector;
2. Waste that is destined for open burning or uncontrolled dump sites is not collected.

The official waste management system includes open burning and uncontrolled dumpsites if collected rubbish is being used for these unregulated activities. It would be incorrect to assume that increasing collection will decrease uncontrolled disposal. The detrimental effects of careless disposal of municipal solid waste demonstrate that careless waste disposal has a number of direct and indirect effects.

Environmental impact

The extended dataset is useful for estimating future trends in environmental impacts that require various types and treatments of waste, including the following:

[i] Circular economy material stocks
Various forecasts can be used to quickly account for the amount of recycling and possibly recyclable materials at both the national and global levels. On the other hand, if there is no outflow, the quantity of recyclable materials that are not recycled tends to build up as a stockpile in landfills and dumps. In order to estimate the amount of potentially recyclable material that has collected in dumps and landfills, we compute these stocks starting in 1965.

[ii] The Disposal of Plastic and Other Dangerous Waste in Waters
It is impossible to put a precise number on the amount of trash that ends up in the ocean due to careless disposal or other forms of debris. Mismanaged plastic waste is defined as the sum of all plastic rubbish handled in open dumps, plastic garbage dumped in landfills in developing countries, and littering debris, which accounts for an extra 2% of total plastic waste (Jambeck et al., 2015). All people residing within a fifty-kilometer radius of the coast are considered part of the Gridded Population of the World v3, as stated by CIESIN 2005 and Jambeck et al. (2015). The absence of relevant data prevents the evaluation or propagation of the uncertainties associated with these models and emission factors. The probable results reveal the sole uncertainty in the waste regression relationships.

[iii] Emissions of greenhouse gases
There are a lot of human-caused greenhouse gas emissions from waste treatment methods. We utilize the IPCC GHG accounting methodology from 2006, revised for 2019 to include estimates for greenhouse gas emissions from waste (IPCC, 2019). The following greenhouse gas sources are differentiated based on their carbon neutrality: N2O from composting and incineration, CO2 from burning non-biogenic sources (such as plastics), and CH4 from landfills and dumps. Earlier in the argument, we covered how the IPCC has not yet included N2O from landfills and dumps in their calculations. To calculate landfill and dump emissions, one uses a first-order decay equation that accounts for climatic zones and the carbon store in various waste types; other treatments use emission factors (IPCC 2006).

iv. Pollution caused by nitrogen
Guo et al. (2010) found that a significant amount of reactive nitrogen (Nr) is present in the leachate produced by SWDS as a result of waste breakdown and rainwater percolation. Assuming a constant C/N ratio of 14 in MSW based on the biodegradable percentage of C (Puyuelo et al., 2011), we calculate potentially mobile Nr using this ratio in relation to the carbon released from emissions computed above. Thus, nitrogen that is able to freely enter leachate and convert into gas emissions, primarily as NH4, is known as potentially mobile nitrogen (Nr) (Mor et al., 2006). Since the production of leachate is dependent on a number of factors, including the dynamics of water flow via landfills and weather conditions, the precise annual emissions of Nr are too uncertain for our analysis. As a result, in SWDS, we omit all but the most publicly available potentially movable Nr stocks.

*[v] **Adverse Impact of Landfilling and Open Dumping***
For example, because to falling recycling rates, Brazil's garbage output increased during the COVID-19 pandemic's economic collapse [Urban and Nakada, 2021]. Destroying natural ecosystems and drastically reducing the amount of plants and animals in Johor, Malaysia is the result of landfilling [Abba et al, 2013]. Also, the practice of dumping unprocessed and unsorted waste has significantly worsened public health issues in South America [Bezama et al., 2007]. Inadequate processing and disposal of 35% of medical waste put public health at risk and may have contributed to the spread of COVID-19 (Urban and Nakada, 2021). A study that included 30 cities in Brazil came to these conclusions. Methane (CH4) emissions are another major GHG associated with open dumps and

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landfills (Margallo et al., 2019). Sites for the release of wastewater and landfills account for seventeen percent of the world's methane emissions. On an annual basis, landfills around the world emit around 29 metric tons of methane, which accounts for almost 8% of all emissions. Landfills in Africa account for the emission of 1.3 metric tons of this total. The rate of landfill gas production rises steadily as municipal solid waste (MSW) accumulates in the landfill discharge. Aldana-Espitia et al. (2017) noted that the emission of gases such as methane and ammonia can pose health hazards, including respiratory illnesses. Because of its high flammability, methane has the potential to cause explosions and flames [Bräutigam, 2012].

Parasites of disease-carrying insects, such as flies, mosquitoes, and rats, thrive in open landfills that store organic waste. Vectors can transmit a variety of diseases, including malaria, dengue fever, and zika virus. Intestinal worms, hepatitis A, diarrhea, and leptospirosis are among water-borne illnesses that might occur.Landfill smells and looks degrade property values, put residents' health at risk, and make it harder for them to make a living. This has a detrimental effect on residents' quality of life. Moreover, ammonia (NH3) emissions from landfills may damage plant leaves and species diversity (Fang et al., 2012). To add insult to injury, landfill chemicals degrade soil quality [Usman, 2017]. Landfills not only contribute to noise pollution but also create dust (Al Ansari, 2012).

Water and air pollution is worse in the summer and fall because of runoff, which can bring diseases, and because it produces unpleasant smells. The substantial emissions of methane and carbon dioxide from landfills have negative effects on human health, including problems with the skin, eyes, nose, and respiratory system [Aldana-Espitia et al, 2017]. Fang (2012) states that ammonia emissions have the potential to cause major health problems, including blindness. Among the numerous dangerous gaseous pollutants from landfills, Menikpura (2013) mentions sulfur oxides. Methane recovery from landfills can reach 60% in Western countries but falls short at less than 20% in China [Raninger, 2009].

Several studies have found that leachate from landfills is poisoning water supplies that people use for drinking and other household purposes, which is a major healthcare concern. Leachates from dumps in Pudong, China, were estimated by Hong et al. (2006) to be 160–180 m3 per day in 2006. As an alternative, according to Henry (2006), properly planned and constructed waste disposal facilities can protect people's health, preserve valuable natural resources, keep drainage systems clear, and prevent leachates from polluting the air, farmland, water (both underground and above ground), animals, and humans. Also, bacteria can work faster in the summer on organic matter, which means that it decomposes faster and releases an unpleasant stench. Case in point: 47% of China's landfills failed to properly manage leachates [Zhuang, 2008].

People put themselves at risk for tetanus, HIV infections, hepatitis B and C, chemical and radioactive hazards, and other related ailments when medical and industrial trash are dumped together with municipal waste [Karshima, 2016]. Psychiatric disorders, gastrointestinal issues, skin and eye irritations, cholera, chest pains, and genetic ailments are among the many side effects that can arise from inappropriate solid waste disposal [Alam and Ahmade, 2013].

Open Burning and Incineration

Toxic air pollution and respiratory diseases like asthma, allergies, low immunity, inflammation, and infections of the throat, nose, and chest are further exacerbated by the open burning of municipal solid waste (MSW). According to reports from Nepal, India, Mexico, Pakistan, Indonesia, Liberia, and Chile, the health implications were comparable. One example is the 22,000 metric tons of pollution released annually by open incinerator operations in Mumbai. Air pollution and unpleasant smells in Thailand were recorded by Mongkolchaiarunya as a result of garbage burning. According to Hong et al. (2006), burning plastic trash produces dioxins and hydrochloric acid in levels that are detrimental to human health. These compounds can lead to allergies, cancer, and hemoglobin deficiency. People who live far from landfills and open fires also have a disproportionately hard time breathing clean air.

Considerations for Other Methods of Disposal

A great deal of work is going on all over the globe. Included in this category are:
[i] Composting
The process of composting utilizes microorganisms that occur naturally, such bacteria and fungi, to decompose organic waste into smaller pieces. This method is used for biological waste disposal. Despite halving organic waste and using compost in farming, composting still produces significantly more carbon dioxide than alternative disposal options.
Examples of countries where composting is more eco-friendly than anaerobic digestion and burning include Korea. Based on the researcher's findings, composting has a 2.4 times greater environmental impact than incineration. Several studies have linked composting to various health issues, including as bronchial asthma, extrinsic allergic alveolitis, sore throats, dry coughs, and blocked noses.

Implications and Recommendations

While every waste treatment technique has drawbacks of its own, some are less detrimental to the environment and human health than others. The main effects of such non-sustainable SWM methods are listed below.

1. Organic garbage that has not been collected from bins, containers, or open landfills harbors rats, insects, and reptiles that can infect people with diseases.
2. The breakdown of organic wastes, which occurs more frequently in the summer, and leachates, which spread and contaminate receiving subsurface and surface waters, also contribute to the odor.
3. Methane is released from biodegradable trash that is breaking down in anaerobiotic settings in open dumps and unengineered landfills. Methane can result in explosions and fires and is a major contributor to global warming.
4. Non-biodegradable garbage, such as used tires, plastics, bottles, and tins, clogs waterways and pollutes the environment, providing mosquito breeding grounds and raising the risk of diseases including dengue, malaria, and West Nile fever.
5. The open burning of MSW releases pollutants into the environment, which raises the risk of bacterial infections, allergies, asthma, anemia, inhalation problems, nose and throat infections, and inflammation.
6. Uncontrolled burning emits fine particles that are a key contributor to respiratory illnesses and creates pollution. It also makes a major contribution to GHG emissions and urban air pollution.
7. Burning and disposing of waste are linked to cancer, hepatitis C, developmental abnormalities in children, poisoning, biomarkers, deaths, and emotional effects.

Conclusion

Thus, steps that can eventually lessen these effects and move toward more sustainable SWM need to be developed and implemented. Multi-stakeholder participation is necessary at every level of the process due to the increasing complexity, expenses, and coordination of SWM. Setting aside funds, offering technical support, fostering good governance, and fostering teamwork are some of the

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essential elements of the Municipal Solid Waste Management process that are necessary to successfully safeguard the environment and public health. The primary parties involved in Municipal Solid Waste Management (MSWM) include local governments, the private sector, non-governmental organizations (NGOs), donor agencies, residents, and unofficial garbage collectors and scavengers. Each of these parties has a collaborative role to play, particularly with regards to roles that are sustainable and effective.

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