

Environmental Sustainability Effects of Solid Waste Management Practices in Developing Regions

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Abstract: *Solid waste management (SWM) is a crucial duty of city managers and serves as a reliable indicator of good governance. Efficient solid waste management (SWM) reduces negative health and environmental effects, preserves resources, and enhances the quality of life in urban areas. Nevertheless, the use of unsustainable solid waste management systems, worsened by the rapid growth of metropolitan areas and the constraints of limited finances and institutions, have a detrimental effect on both public health and environmental sustainability. This review article evaluates the effects of solid waste management (SWM) methods on both human and environmental health in cities of the Global South, which are crucial for the future of global urbanization. The study utilizes a desktop research technique that involves conducting a thorough review of secondary data and literature, which includes official papers and published publications. It has been discovered that the ordinary SWM methods involve the combination of residential and commercial waste with hazardous materials during the storage and management process. trash storage predominantly occurs in outdated or inadequately maintained facilities, such as storage containers. Additionally, the transportation system for trash is frequently lacking and operates in an informal manner. The primary means of disposal are mostly through unregulated dumping, open-air incineration, and landfills. The adverse effects of such methods encompass air and water contamination, deterioration of land quality, release of methane and toxic leachate, and alteration of climatic patterns. These repercussions have substantial environmental and public health expenses for inhabitants, particularly those belonging to marginalized social groups. The article provides recommendations for reducing the public and environmental health concerns connected with the current solid waste management techniques in the Global South..*

Keywords: climate change; environmental pollution; health impacts; landfilling; land degradation; solid waste management; storage and handling; recycling; risk exposure

I. INTRODUCTION

Solid waste management (SWM) remains a significant socioeconomic and governance issue, particularly in urban regions facing the challenges of rapid population development and increased garbage production. The significance of Solid Waste Management (SWM) in attaining sustainable development is underscored in various international development agendas, charters, and visions. Sustainable solid waste management (SWM) can contribute to achieving various United Nations' Sustainable Development Goals (SDGs), including SDG6 (ensuring clean water and sanitation), SDG11 (creating sustainable cities and inclusive communities), SDG13 (mitigating climate change), SDG15 (protecting life on land), and SDG12 (demonstrating sustainable consumption and production patterns).

Additionally, it cultivates a self-sustaining urban economy that encourages the decrease in the use of limited resources, the reuse and recycling of materials to eliminate waste, the reduction of pollution, cost savings, and the promotion of environmentally-friendly economic growth.

Nevertheless, as the global population is projected to increase to 8 billion by 2025 and 9.3 billion by 2050, with approximately 70% residing in urban regions, cities worldwide will confront a formidable issue of solid waste management (SWM). This challenge will persist despite the concurrent factors of economic growth, enhanced lifestyle,

and consumerism. In developing nations, the majority of urban areas only manage to collect 50-80% of the waste produced, while allocating 20-50% of their budgets for this purpose. Out of these budgets, 80-95% is specifically allocated for the collection and transportation of waste. In addition, numerous low-income countries only manage to collect a mere 10% of the waste produced in suburban regions. This lack of waste management contributes to various public health and environmental hazards, such as an increased occurrence of diarrhea and acute respiratory infections among individuals, especially children, residing in close proximity to garbage dumps. Challenges that hinder the effectiveness of municipal solid waste management (SWM) include a lack of awareness, appropriate technologies, financial resources, and strong governance.

The primary focus of municipal solid waste management (SWM) in many developing cities has been the removal of garbage from households and businesses. However, there has been a lack of emphasis on the proper disposal and management of this waste. Garbage collected from houses in most developing nations is often disposed of in landfills or dumpsites. However, it is expected that the bulk of these landfills and dumpsites will reach their maximum limits over the next ten years. The practice of disposing waste by dumping or incinerating it in open areas, typically located near impoverished populations on the outskirts of the city, or by discarding junk into water bodies, was considered an acceptable strategy for waste management. Furthermore, numerous communities continue to utilize outdated or inadequately maintained facilities, resulting in unregulated dumping or the burning of waste in open-air settings. Frequently, these actions have an impact on marginalized social groups in close proximity to the disposal sites. Furthermore, this strategy presents numerous sustainability issues, such as the exhaustion of resources, contamination of the environment, and public health concerns, such as the transmission of communicable diseases.

Since the emergence of the environmental movement in the 1960s, there has been a widespread recognition of the environmental and public health dangers associated with unsustainable solid waste management systems. During the 1970s and beyond, solid waste management (SWM) was seen as a technical problem that required technological solutions. As a result, the focus and financial resources were directed into acquiring garbage collection equipment. In the 1990s, the perspective on contemporary technology's ability to decrease dangerous emissions shifted. It was realized that governments were unable to efficiently evacuate and dispose of rubbish without the active participation of service customers and other stakeholders. The public sector in the global South's failure to adequately address solid waste management (SWM), combined with pressure from financial institutions and other donor agencies, resulted in the implementation of privatization policies towards the end of the decade. Nevertheless, due to the inability of privatization to deliver municipal solid waste management (SWM) services to impoverished and disenfranchised populations, there is a shift in the current worldwide approach to tackling municipal SWM issues.

An enhanced waste management strategy places emphasis on sustainable techniques such as minimizing production, categorizing garbage, reusing materials, recycling, and recovering energy. This approach is favoured over conventional methods including landfilling, open dumps, and open incineration. This emerging technique, currently in its early stages but gaining growing recognition in the Global South, is characterized by its inclusivity and environmentally-friendly nature. It also has a reduced detrimental impact on human health and the environment compared to conventional approaches. Hence, it is imperative to evaluate solid waste management (SWM) practices in the Global South and their effects on the environment and human well-being, as this region is projected to account for 90% of the projected increase in the urban population by 2050. Currently, there have been limited studies conducted on the effects of SWM practices on human health and the environment worldwide.

Hence, this review article aims to fill this vacuum in information by evaluating the adverse effects of the prevailing solid waste management systems on both human and environmental well-being.

II. DISCUSSION BASED ON AVAILABLE LITERATURE

As previously mentioned, unsustainable solid waste management practices have numerous adverse effects on both individuals and the environment. While every waste treatment process has its own negative consequences, several procedures have less severe effects on both human health and the environment compared to others. The subsequent text provides a concise overview of the significant consequences resulting from these unsustainable solid waste management strategies.

Unattended organic waste found in bins, containers, and open landfills serves as a breeding ground for rats, insects, and reptiles that can transmit diseases to humans. In addition, it generates unpleasant smells as a result of the breakdown of organic waste, particularly during the summer. It also produces leachates that move and pollute both underground and surface waters.

Unregulated waste disposal sites and landfills that are not designed with proper engineering methods generate methane gas as a result of the decomposition of biodegradable waste in the absence of oxygen. Methane is a significant contribution to the phenomenon of global warming, and it has the potential to ignite flames and produce explosions.

Non-biodegradable garbage, including abandoned tires, plastics, bottles, and tins, contaminates the soil and accumulates water, so generating favorable conditions for mosquito breeding and elevating the likelihood of diseases such as malaria, dengue, and West Nile fever.

The act of openly burning municipal solid waste (MSW) releases pollutants into the air, which in turn leads to a higher occurrence of nose and throat infections, inflammation, respiratory difficulties, bacterial infections, anemia, weakened immune system, allergies, and asthma.

Unregulated combustion leads to the formation of smog and the emission of fine particles, which are a significant contributor to respiratory illnesses. Furthermore, it has a substantial role in the exacerbation of urban air pollution and the release of greenhouse gases.

Incineration and landfilling are linked to adverse reproductive outcomes in women, developmental abnormalities in children, cancer, hepatitis C, psychosocial consequences, poisoning, biomarkers, injuries, and mortality.

Hence, it is imperative to develop and adhere to strategies aimed at achieving a more sustainable solid waste management (SWM) system in order to effectively minimize these adverse effects. Multi-stakeholder involvement is necessary at every level of the solid waste management (SWM) process due to the increasing complexity, costs, and coordination involved. Allocating resources, offering technical support, ensuring effective governance and cooperation, and safeguarding the environment and human well-being are key criteria for the success of solid waste management (SWM). Therefore, local governments, the commercial sector, donor agencies, non-governmental organizations (NGOs), citizens, and informal garbage collectors and scavengers all have specific tasks to fulfill in a coordinated effort to achieve effective and sustainable solid waste management (SWM). Here are some important practical suggestions for reducing the harmful effects of unsustainable solid waste management techniques mentioned earlier.

Initially, cities should strategize and execute a comprehensive solid waste management (SWM) approach that prioritizes enhancing the functioning of local governments to handle all aspects of SWM in a sustainable manner. These aspects include waste generation, waste separation, waste transportation, waste transfer/sorting, waste treatment, and waste disposal. In order for this method to be successful, it is necessary for all stakeholders mentioned above to be actively engaged, taking into account the environmental, financial, legal, institutional, and technical issues that are relevant to each specific local context. Life Cycle Assessment (LCA) can also assist in the selection of the approach and formulation of the waste management plan. Therefore, it is crucial to meticulously choose the SWM technique in order to protect citizens from adverse health and environmental consequences.

Furthermore, it is imperative for local authorities to rigorously implement environmental regulations and enhance surveillance of citizens' obligations in terms of sustainable waste storage, collection, and disposal. This includes addressing the health risks associated with inadequate solid waste management, as evidenced by the prevalent issue of garbage littering in many cities of the Global South. Furthermore, it is imperative to impose penalties for infractions of waste legislation in order to deter unsustainable actions. Furthermore, it is imperative for local authorities to guarantee that garbage collection services possess sufficient geographical scope, encompassing impoverished and minority areas. Local governments should adopt more effective solid waste management (SWM) policies that prioritize trash reduction, reuse, and recycling in order to promote a circular economy and ensure sustainable growth.

Furthermore, in order to achieve efficient solid waste management (SWM), it is necessary to actively encourage and cultivate favorable public attitudes towards sustainable waste management. Hence, it is necessary to implement public awareness campaigns across various media platforms, including print, electronic, and social media, in order to promote the cessation of littering and encourage individuals to adopt appropriate trash disposal and sorting methods. Additionally, it is crucial to prioritize the provision of sorting bins and raise public awareness about waste sorting at the source. This approach can effectively expedite and improve subsequent solid waste management (SWM)

procedures while reducing their negative impacts. This is supported by several studies. Furthermore, non-governmental and community-based groups have the potential to facilitate the promotion of waste reduction, separation, and sorting at the point of origin, as well as material reuse and recycling. In the context of Vietnam, Tsai et al. discovered that the effective collaboration among many parties involved and the establishment of suitable legal and policy frameworks are essential factors in attaining sustainable solid waste management (SWM).

Additionally, it is imperative to employ eco-friendly technologies or enhance current infrastructure to address this issue. Certain researchers have a preference for incineration as a method of garbage disposal, especially when it comes to material that cannot be recycled. For instance, Xin et al. discovered that the processes of incineration and recycling, Composting led to a significant decrease of 70.82% in greenhouse gas (GHG) emissions from solid waste in Beijing. In the city of Tehran, Iran, Maghmoumi et al. discovered that the most effective approach for decreasing greenhouse gas (GHG) emissions is to burn 50% of the waste, dispose of 30% in landfills, and recycle 20%. Regarding organic waste, multiple studies demonstrate a predilection for composting and the production of biogas. While several studies have supported a total prohibition on landfilling, it is advisable to regulate it through enhanced methods for identifying leaks, as well as collecting leachate and biogas. Several researchers have proposed an integrated approach combining biological and mechanical treatment (BMT) for solid waste. Kenya's waste-to-biogas program and prohibition on landfill and open burning efforts are projected to decrease greenhouse gas (GHG) and PM2.5 emissions from waste by over 1.1 million tons and more than 30% respectively by 2035. A well-designed waste disposal facility plays a crucial role in safeguarding essential natural resources such as plants, animals, surface and subterranean water, air, and soil.

Furthermore, the extraction and reuse of materials, energy, and nutrients are crucial components of efficient solid waste management (SWM). This practice not only supports the lives of numerous individuals but also enhances their health and safeguards the environment. For instance, by recycling 24% of municipal solid waste (MSW) in Thailand, the adverse health, social, environmental, and economic effects caused by disposal sites were reduced. Waste pickers are essential for achieving waste circularity and should be included in the solid waste management system, including participating in decision-making processes. Furthermore, it is imperative to provide enhanced training and proper equipment to staff engaged in waste collection to effectively manage hazardous material. In addition, the adoption of green consumption practices, including the utilization of bioplastics, can effectively mitigate the adverse effects of solid waste on the environment.

Finally, in order to achieve effective solid waste management (SWM), local authorities need to address various challenges related to SWM. These challenges include the absence of well-thought-out SWM plans, ineffective waste collection, segregation, and recycling practices, inadequate budgets, a shortage of qualified waste management professionals, and weak governance. Once these challenges are addressed, it is important to establish a comprehensive financial regulatory framework in an integrated manner. The effectiveness of a solid waste management (SWM) system is influenced by various aspects, including the pace at which garbage is generated, population density, economic status, degree of commercial activity, cultural practices, and the specific city or region being considered. A sustainable solid waste management (SWM) system aims to safeguard human health and the environment.

III. CONCLUSION

Due to the rapid increase in global solid waste generation rates, which outpaces urbanization, and the presence of inadequate solid waste management (SWM) systems, local governments and urban inhabitants frequently rely on unsustainable SWM techniques. These practices encompass the mixing of domestic and commercial rubbish with hazardous waste during storage and processing, the storage of garbage in outdated or poorly managed facilities, inadequate transportation methods, the use of open-air incinerators, unregulated dumping, and the use of non-engineered landfills. The consequences of such methods encompass air and water contamination, soil deterioration, alterations in climate patterns, as well as the release of methane and dangerous leachate. Furthermore, these effects result in substantial environmental and public health expenses for individuals residing in underprivileged social communities, namely.

Insufficient solid waste management (SWM) is linked to negative public health outcomes and is a significant obstacle to achieving environmental quality and sustainable development in cities. Successful community engagement in solid waste management necessitates the promotion of favorable public attitudes. It is necessary to implement public

awareness campaigns using various forms of media, such as print, electronic, and social media, in order to promote the cessation of littering and the adoption of correct waste disposal procedures. Inadequate solid waste management (SWM) also led to water pollution and the presence of bad air in urban areas. Further research is required to examine how the unique characteristics of each country in the Global South can impact the selection of solid waste management (SWM) approaches, elements, aspects, technology, and legal/institutional frameworks that are suitable for each specific location.

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