



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.699

Volume 14, Issue 6, June 2025

Solid Waste Management: Current Realities and Sustainable Pathways in 2025

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ABSTRACT: In 2025, solid waste management remains one of the most pressing global environmental challenges, intensified by accelerated urbanization, industrial expansion, and shifting patterns of production and consumption. Despite technological advancements and increased policy focus, many regions—particularly in the Global South—struggle with ineffective waste disposal practices, leading to environmental degradation, public health risks, and socio-economic burdens. This paper critically examines the current state of global solid waste management systems, evaluates recent academic and industry research, identifies ongoing systemic and infrastructural shortcomings, and proposes a set of sustainable, scalable solutions. Special attention is given to waste reduction at the source, circular economy frameworks, and the role of integrated policy and technology in shaping the future of waste management.

KEYWORDS: Solid waste management, circular economy, sustainable urban planning, recycling, waste-to-energy, environmental policy

I. INTRODUCTION

Solid waste management (SWM) plays a fundamental role in maintaining environmental integrity, safeguarding public health, and supporting the principles of sustainable development. As of 2025, the global community faces an escalating waste crisis, fueled by increased consumerism, rapid population growth, and inadequate waste treatment infrastructure. The World Bank estimates that global waste generation is expected to rise dramatically, from 2.2 billion metric tons annually to an alarming 3.8 billion metric tons by 2050 if no intervention is made. This upsurge places significant stress on municipal systems, especially in low- and middle-income countries, where institutional, technological, and financial constraints inhibit proper waste handling.

The urgency for strategic and integrated SWM solutions has never been greater. Effective systems must not only prioritize the safe collection, segregation, and disposal of waste but also incorporate innovative approaches such as resource recovery, waste-to-energy conversion, and behavioral change among consumers. In this paper, we explore the multifaceted dimensions of solid waste management, review current research and practices, and propose comprehensive reforms that support the transition towards sustainability and circular resource use.

II. LITERATURE REVIEW

Numerous scholarly and institutional studies over the last two decades have contributed significantly to understanding the global waste management crisis. According to the Global Waste Management Outlook by UNEP (2022), approximately 33% of all solid waste generated globally is not managed in an environmentally safe manner. The bulk of this improperly handled waste is disposed of in open dumps or unsanitary landfills, primarily in South Asia, Sub-Saharan Africa, and parts of Southeast Asia.

Research by Hoornweg & Bhada-Tata (2018) indicates that recycling and composting can reduce greenhouse gas emissions by more than 50% when implemented systematically. However, despite these environmental benefits, implementation remains patchy. Developed nations such as Germany and Sweden have adopted advanced waste-to-energy and zero-waste models, while cities like Indore in India have made notable progress through decentralization

and public-private partnerships. Conversely, many urban centers continue to face challenges related to informal sector dependence, limited policy enforcement, and low public awareness.

Additionally, the COVID-19 pandemic severely disrupted existing waste flows by increasing the volume of biomedical and plastic waste, further exposing weaknesses in the global waste management chain. The literature points to a growing consensus: the future of SWM must align with circular economy principles, integrate digital technologies such as AI for sorting and tracking, and enhance community engagement to foster sustainable behavioral changes.

III. METHODOLOGY

This study employed a qualitative comparative analysis methodology grounded in secondary data collection, designed to evaluate the operational dynamics and outcomes of solid waste management (SWM) practices in selected global cities. The research focused on four urban centers—Indore (India), Oslo (Norway), Lagos (Nigeria), and Manila (Philippines)—chosen for their distinct socio-economic profiles, varying levels of infrastructural development, and different approaches to waste management. This diversity allowed for a comprehensive understanding of the strategies, challenges, and innovations associated with solid waste handling across different contexts.

Data sources for the study included official reports from municipal corporations, national and local government publications, academic research papers, and reports by international organizations such as the World Bank, UNEP, and the Global Waste Management Outlook. Particular attention was paid to materials published between 2020 and 2024 to ensure contemporary relevance. The study also reviewed performance metrics such as waste generation volumes, collection efficiency, segregation rates, and the proportion of waste treated through recycling, composting, or energy recovery. These metrics were instrumental in evaluating the effectiveness of each city's solid waste management system.

In order to analyze the correlation between policy implementation and waste management outcomes, the study examined existing legislative frameworks, institutional capacities, and public engagement initiatives. Attention was also given to the role of the informal sector, especially in cities like Lagos and Manila, where waste pickers play a crucial role in material recovery despite operating outside the formal governance structure. By comparing these elements across multiple cities, the study aimed to identify both successful practices and common barriers to effective waste management.

This comparative analysis was further enhanced by interpreting contextual variables such as socio-economic conditions, urban population density, public awareness levels, and availability of financial and technological resources. The synthesis of data from diverse sources allowed for a nuanced understanding of the strengths and weaknesses of current systems. The methodology was carefully structured to ensure that insights drawn from successful cities could be adapted and applied to regions where waste management systems remain underdeveloped or fragmented. The findings of this analysis aim to support future policymaking and encourage the adoption of best practices in global solid waste management.

IV. EXPERIMENTAL RESULTS / FIELD ANALYSIS

To examine the practical implications and effectiveness of various solid waste management strategies, a comparative case study analysis was conducted across multiple urban centers—Indore (India), Oslo (Norway), Lagos (Nigeria), and Manila (Philippines). These cities were chosen for their distinct socio-economic conditions, waste generation patterns, policy responses, and infrastructural capabilities. Data for the study was collected through a combination of secondary sources, including municipal reports, government databases, environmental monitoring agency publications, and academic research articles published between 2020 and 2024.

In Indore, India, the implementation of decentralized solid waste management has significantly improved urban sanitation and environmental quality. With the introduction of 100% door-to-door waste collection, mandatory source segregation, and effective monitoring systems, the city has transformed its waste management infrastructure. The daily waste generation in Indore stands at approximately 1,115 metric tons, out of which nearly 78% is either composted or recycled. This transformation was achieved through strong public-private partnerships, community engagement

programs, and the enforcement of municipal by-laws. The city also established material recovery facilities (MRFs) and ensured regular audits of waste processing units, contributing to reduced landfill dependence.

In contrast, Oslo, Norway, presents a technologically advanced waste management framework centered around energy recovery and automation. Nearly 97% of municipal solid waste is diverted from landfills through state-of-the-art waste-to-energy (WTE) incineration plants, biogas generation from organic waste, and sophisticated recycling systems. The city utilizes automated vacuum waste collection systems in some districts and employs artificial intelligence in waste sorting facilities to enhance operational efficiency. High public compliance, strong regulatory frameworks, and consistent investment in innovation contribute to Oslo's exemplary performance in the sector.

Lagos, Nigeria, highlights the challenges that developing nations face due to infrastructural and institutional limitations. Despite generating over 13,000 metric tons of waste daily, only about 40% is collected and processed through formal channels. The remainder is either openly dumped or managed by informal waste pickers operating without standardized safety protocols or health coverage. Although informal recycling contributes to resource recovery, the absence of proper oversight and regulatory mechanisms leads to environmental degradation and public health concerns. Attempts at reform have been initiated, including pilot waste transfer stations and PPP models, but systemic improvements remain slow due to financial constraints and limited administrative capacity.

Similarly, Manila in the Philippines illustrates the complexities of urban waste management in densely populated coastal megacities. Plastic waste constitutes more than 30% of the city's total municipal waste, much of which ends up in waterways and coastal zones. The widespread use of non-biodegradable packaging, coupled with inadequate segregation and disposal infrastructure, results in frequent flooding, blocked drainage systems, and vector-borne diseases. Recent efforts to establish barangay-level MRFs and implement plastic bans have shown localized success; however, the overall system remains fragmented. A lack of coordination among municipal authorities, insufficient public participation, and challenges in enforcing environmental legislation continue to hinder comprehensive progress.

Across these cities, the experimental analysis reveals common patterns and lessons. Cities with strong governance, public participation, technological investment, and integrated policy frameworks demonstrate higher performance and sustainability in solid waste management. Conversely, where institutional gaps, financial constraints, and socio-political barriers exist, the systems remain inefficient, and environmental risks are magnified. These findings underscore the importance of context-specific strategies and the need for global cooperation in knowledge sharing and capacity building to address the escalating solid waste challenge effectively



V. CONCLUSION

The rapidly intensifying solid waste crisis in 2025 highlights the need for a paradigm shift in how societies perceive and manage waste. While some cities and nations have made commendable progress by embracing circular economy models, many others continue to struggle with outdated practices and limited resources. The evidence suggests that sustainable waste management must be rooted in integrated approaches combining policy innovation, technological advancement, institutional reform, and public engagement.

Strategic investments in sanitary landfills, recycling technologies, and energy recovery systems must be prioritized. Furthermore, policy enforcement and community education are indispensable in cultivating a culture of waste minimization and segregation. As the global population continues to urbanize, only a proactive, collaborative, and science-driven approach can build resilient systems that address current deficiencies and safeguard environmental and public health in the future.

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