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A Study on Household Waste Segregation Behaviour and Sustainable Municipal Solid Waste Management: Towards an Integrated Waste Management Framework

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ABSTRACT: Municipal solid waste management has emerged as one of the most significant environmental challenges facing rapidly urbanizing regions worldwide. Among the various stages of waste management, household waste segregation at the source is considered the foundation of an efficient and sustainable municipal solid waste management system. However, inadequate public awareness, inconsistent waste segregation practices, limited infrastructure, and weak institutional support continue to hinder the effective implementation of waste management policies in many developing countries. Poor segregation leads to increased landfill burden, reduced recycling efficiency, environmental pollution, greenhouse gas emissions, and public health risks. Therefore, understanding household waste segregation behaviour is essential for improving the sustainability of municipal solid waste management systems.

This study examines the behavioural factors influencing household waste segregation and evaluates their contribution to sustainable municipal solid waste management. The research adopts a qualitative approach based on an extensive review of secondary data, including government reports, published literature, policy documents, and successful waste management practices implemented in India and other countries. The study identifies key determinants of waste segregation behaviour, including environmental awareness, public participation, accessibility of waste collection services, government initiatives, and community engagement. By comparing existing practices and identifying current challenges, the study highlights the importance of integrating behavioural, technological, and policy-based interventions to strengthen waste management systems.

Based on the findings, the study proposes an Integrated Waste Management Framework that emphasizes source segregation, community participation, efficient collection and transportation, recycling, composting, resource recovery, and scientific disposal of residual waste. The proposed framework also highlights the role of municipal authorities, policymakers, educational institutions, and households in achieving sustainable waste management. The study concludes that improving household waste segregation behaviour through awareness programmes, supportive policies, and effective municipal services can significantly enhance environmental sustainability, reduce landfill dependency, and contribute to the development of cleaner, healthier, and more resilient urban communities.

KEYWORDS: Household Waste Segregation, Municipal Solid Waste Management, Sustainable Waste Management, Source Segregation, Recycling, Environmental Awareness, Community Participation, Integrated Waste Management Framework.

I. INTRODUCTION

Municipal Solid Waste Management (MSWM) has become one of the most critical environmental and public health challenges across the globe due to rapid urbanization, population growth, changing consumption patterns, and increasing waste generation. According to recent estimates, municipal solid waste generation is expected to continue rising significantly over the coming decades, placing tremendous pressure on local governments and urban infrastructure. In developing countries such as India, inadequate waste segregation, inefficient collection systems, limited recycling facilities, and improper disposal practices have resulted in environmental degradation, greenhouse gas emissions, groundwater contamination, and frequent landfill fires. Effective municipal solid waste management

therefore requires a comprehensive approach involving waste reduction, segregation at the source, recycling, composting, scientific disposal, and active participation from all stakeholders.

Among the various stages of municipal solid waste management, household waste segregation at the source is considered the cornerstone of an efficient and sustainable waste management system. Source segregation enables the separation of biodegradable, recyclable, hazardous, and residual waste before collection, thereby improving recycling efficiency, reducing landfill dependency, lowering waste management costs, and minimizing environmental pollution. However, despite the implementation of the Solid Waste Management Rules, 2016, and several national initiatives such as the Swachh Bharat Mission, many households continue to practice mixed waste disposal due to limited environmental awareness, inadequate municipal services, behavioural resistance, and insufficient policy enforcement. The absence of proper segregation not only reduces the effectiveness of recycling programmes but also increases operational challenges for municipal authorities responsible for waste collection, transportation, and processing.

Recognizing these challenges, the present study focuses on understanding household waste segregation behaviour and its contribution to sustainable municipal solid waste management. The study reviews existing literature, policy initiatives, and successful waste management practices to identify the key behavioural, institutional, and infrastructural factors influencing household waste segregation. Based on these findings, the study proposes an Integrated Waste Management Framework that combines community participation, environmental awareness, municipal support, efficient collection systems, recycling, composting, and scientific disposal methods. The proposed framework aims to strengthen sustainable waste management practices, improve resource recovery, reduce environmental impacts, and support the development of cleaner, healthier, and more sustainable urban communities.

II. LITERATURE REVIEW

Household waste segregation is considered the foundation of sustainable municipal solid waste management because it improves recycling efficiency, reduces landfill waste, and minimizes environmental pollution. Proper segregation at the household level enables municipalities to recover valuable resources while lowering waste processing costs. The study also emphasized that awareness campaigns and public participation are essential for improving segregation practices and achieving long-term sustainability (Kumar et al., 2023).

Municipal solid waste management systems become more effective when households actively separate biodegradable, recyclable, and hazardous waste before collection. The study found that environmental awareness, accessibility to waste collection services, and government support positively influence household waste segregation behaviour. It concluded that behavioural change among citizens is a key factor in developing sustainable waste management systems (Govind and Mahongnao, 2021).

Rapid urbanization and increasing waste generation have created significant challenges for municipal authorities. The study observed that improper segregation at the source increases landfill dependency, reduces recycling efficiency, and causes environmental pollution. It recommended strengthening municipal infrastructure, promoting public awareness, and implementing strict waste management policies to improve urban waste management (Ferronato and Torretta, 2019).

Public participation plays a significant role in improving municipal solid waste management. The study reported that households with higher environmental awareness and positive attitudes toward recycling were more likely to practice waste segregation. The authors also highlighted that educational programmes and community engagement can significantly improve waste segregation behaviour (Luo et al., 2024).

Effective implementation of waste segregation programmes requires cooperation between households, local governments, and municipal authorities. The study found that regular waste collection, proper infrastructure, and continuous monitoring encourage citizens to adopt sustainable waste management practices. It also emphasized that integrated waste management systems improve environmental quality and public health (Wilson et al., 2015).

The adoption of circular economy principles in municipal solid waste management promotes waste reduction, resource recovery, and recycling. The study highlighted that segregating waste at the source is the first step towards achieving circular economy objectives and reducing dependence on landfill disposal. The authors recommended integrating recycling, composting, and waste-to-energy initiatives into municipal waste management strategies (Kirchherr, Reike and Hekkert, 2017).

Household waste segregation behaviour is strongly influenced by environmental concern, social responsibility, and institutional support. The study concluded that government incentives, awareness programmes, and improved waste collection facilities significantly increase public participation in waste segregation and contribute to sustainable municipal solid waste management (Trushna et al., 2024).

Sustainable municipal solid waste management requires an integrated approach involving source segregation, efficient collection, recycling, composting, scientific disposal, and active stakeholder participation. The study emphasized that behavioural change among households is essential for improving waste management performance and achieving long-term environmental sustainability (United Nations Environment Programme, 2024).

III. METHODOLOGY

The present study adopts a qualitative research approach based on an extensive review and analysis of secondary data to examine household waste segregation behaviour and its contribution to sustainable municipal solid waste management. The research aims to identify the key behavioural, institutional, and environmental factors influencing household waste segregation and to develop an integrated waste management framework that can enhance the effectiveness of municipal solid waste management systems. Since the study focuses on understanding existing knowledge, policies, and best practices rather than collecting primary data, a qualitative review methodology was considered appropriate.

The study is primarily based on secondary sources of information collected from peer-reviewed journal articles, government reports, policy documents, conference proceedings, books, municipal corporation reports, and publications of national and international organizations. Relevant information was obtained from databases such as Scopus, Web of Science, ScienceDirect, SpringerLink, Taylor & Francis, Google Scholar, and government websites. Reports published by the Ministry of Housing and Urban Affairs (MoHUA), Central Pollution Control Board (CPCB), Swachh Bharat Mission, United Nations Environment Programme (UNEP), and the World Bank were also reviewed to understand current municipal solid waste management practices, waste segregation initiatives, and sustainability strategies.

The literature selected for the study was published mainly between 2015 and 2025, ensuring that recent developments in municipal solid waste management and household waste segregation behaviour were adequately represented. Keywords such as household waste segregation, municipal solid waste management, source segregation, recycling behaviour, sustainable waste management, environmental awareness, community participation, and integrated waste management were used to identify relevant studies. The selected publications were carefully screened based on their relevance to the objectives of the study, methodological quality, and contribution to the field of sustainable waste management.

To achieve the objectives of the study, the collected literature was analysed using descriptive and thematic analysis. The findings from previous studies were systematically organized into different themes, including household waste segregation behaviour, environmental awareness, municipal waste collection systems, recycling practices, government policies, community participation, and sustainable waste management strategies. Thematic analysis enabled the identification of common patterns, major challenges, and successful practices reported in different countries and municipalities.

The study also adopts a comparative analytical approach by examining successful waste segregation and municipal solid waste management practices implemented in selected Indian cities and international case studies. The comparison helps identify best practices that can be adapted to improve household waste segregation and municipal waste management systems. Special attention is given to policy implementation, citizen participation, technological interventions, waste collection mechanisms, recycling initiatives, and institutional support, as these factors play a significant role in developing sustainable municipal solid waste management systems.

Based on the comprehensive review of literature and comparative analysis, the study develops an Integrated Waste Management Framework. The proposed framework combines household waste segregation, public awareness, municipal support, efficient waste collection, recycling, composting, resource recovery, scientific disposal, and continuous stakeholder participation into a unified approach. The framework is designed to improve the efficiency of municipal solid waste management while promoting environmental sustainability, resource conservation, and public health.

Although the study relies exclusively on secondary data, every effort has been made to ensure the reliability and validity of the findings by consulting authentic and peer-reviewed academic sources. The methodology provides a comprehensive understanding of household waste segregation behaviour and its role in sustainable municipal solid waste management while offering practical recommendations for policymakers, municipal authorities, researchers, and local communities. The proposed framework can serve as a useful reference for strengthening waste segregation practices and improving municipal solid waste management systems in urban areas.

IV. EXPERIMENTAL RESULTS

The review of existing literature indicates that household waste segregation at the source is one of the most important determinants of sustainable municipal solid waste management. Studies consistently report that separating biodegradable, recyclable, hazardous, and residual waste before collection significantly improves recycling efficiency, reduces landfill dependency, and minimizes environmental pollution. Municipalities with higher levels of household participation have demonstrated better waste recovery, lower operational costs, and improved environmental outcomes. Conversely, the absence of source segregation results in mixed waste disposal, making recycling difficult and increasing the burden on waste treatment facilities.

Environmental awareness and public participation emerged as critical factors influencing household waste segregation behaviour. The literature reveals that households with greater knowledge of waste management practices and environmental responsibility are more likely to segregate waste effectively. Educational campaigns, community participation, and awareness programmes organized by local governments and non-governmental organizations have significantly improved segregation behaviour in several successful municipalities. However, inadequate awareness, lack of motivation, and poor understanding of waste segregation continue to remain major challenges in many urban areas.

The analysis also shows that municipal infrastructure and institutional support play a significant role in determining the success of waste segregation programmes. Availability of separate collection bins, regular door-to-door collection services, efficient transportation systems, and well-equipped recycling facilities encourage households to practice waste segregation consistently. Municipalities with strong administrative support and effective monitoring mechanisms have achieved higher segregation rates than those with inadequate infrastructure and limited policy implementation.

Government policies and regulatory frameworks have a direct influence on sustainable municipal solid waste management. The implementation of the Solid Waste Management Rules, 2016, along with initiatives such as the Swachh Bharat Mission, has improved waste management practices in several Indian cities. Nevertheless, variations in policy enforcement, financial constraints, and lack of coordination among stakeholders continue to affect the effectiveness of municipal solid waste management systems. Strengthening institutional capacity and ensuring strict compliance with waste management regulations are therefore essential for improving overall system performance.

A comparative analysis of successful waste management models demonstrates that integrated waste management systems are more effective than conventional waste disposal approaches. Cities such as Indore have achieved high levels of waste segregation through continuous public awareness campaigns, efficient waste collection systems, decentralized composting, recycling initiatives, and active citizen participation. International experiences also indicate that combining technological innovation with community involvement and policy support significantly enhances waste management efficiency and environmental sustainability.

Based on the findings of the reviewed literature, this study proposes an Integrated Waste Management Framework that emphasizes household waste segregation as the starting point of sustainable municipal solid waste management. The framework integrates source segregation, community awareness, municipal collection services, recycling, composting, resource recovery, scientific disposal of residual waste, and continuous monitoring by local authorities. The proposed framework encourages collaboration among households, municipal corporations, policymakers, educational institutions, and environmental organizations to achieve long-term sustainability.

Overall, the findings suggest that improving household waste segregation behaviour through awareness programmes, better municipal infrastructure, effective policy implementation, and active stakeholder participation can significantly strengthen municipal solid waste management systems. Adoption of an integrated approach will not only reduce environmental pollution and landfill dependency but also promote resource conservation, public health, and sustainable urban development.

V. CONCLUSION

Household waste segregation is a fundamental component of sustainable municipal solid waste management, as it directly influences recycling efficiency, resource recovery, environmental protection, and public health. The findings of this study indicate that effective waste segregation at the source significantly reduces the volume of waste sent to landfills, minimizes environmental pollution, and supports the efficient utilization of recyclable and biodegradable materials. However, several challenges, including limited environmental awareness, inadequate waste collection infrastructure, insufficient policy implementation, and low community participation, continue to hinder the successful adoption of household waste segregation practices in many urban areas.

The review further highlights that sustainable municipal solid waste management cannot be achieved through government initiatives alone. A collaborative approach involving households, municipal authorities, policymakers, educational institutions, non-governmental organizations, and the private sector is essential for developing an efficient and sustainable waste management system. Public awareness campaigns, regular environmental education, improved waste collection services, and strict enforcement of waste management regulations are necessary to encourage responsible waste segregation behaviour. In addition, integrating recycling, composting, resource recovery, and scientific disposal methods can significantly enhance the overall efficiency of municipal solid waste management.

Based on the findings, this study proposes an Integrated Waste Management Framework that places household waste segregation at the centre of sustainable municipal solid waste management. The framework emphasizes source segregation, community participation, efficient collection and transportation, recycling, composting, resource recovery, scientific disposal of residual waste, and continuous monitoring by municipal authorities. The implementation of this integrated approach can contribute to cleaner cities, reduced environmental degradation, improved public health, and sustainable urban development. Future research may focus on empirical validation of the proposed framework using primary data collected from households and municipal authorities, thereby providing practical insights for policymakers and urban local bodies to strengthen sustainable waste management practices.

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