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Household Waste Management in Rajshahi City Corporation: A Review on Contemporary Research

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Abstract: In Bangladesh, household solid waste is a major contributor to environmental pollution, driven by rapid population growth and inefficient management systems. Given the complexity of solid waste management, the performance of individual components—such as solid waste generation, collection, and disposal—significantly influences overall system efficiency. This study aims to propose an optimized and integrated household solid waste management system through a systematic literature review, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Out of an initial pool of 613 peer-reviewed research articles published since 2020, 145 were selected based on their relevance to household waste management, with particular focus on Bangladesh and, more specifically, the Rajshahi City Corporation. This review highlights the current state of household waste practices in the region and explores strategies for efficient waste minimization and resource recovery with the aim of achieving economic benefit. This review underscores the potential for converting household solid waste into renewable resources or energy through anaerobic digestion, pyrolysis, gasification, and incineration by the use of modern transportation technology. These inbound technologies offer promising pathways toward sustainable waste-to-resource solutions for the city of Rajshahi and similar urban entities.

Keywords: HH Solid Waste Generation, Waste Transformation, Management System

Introduction

As the global population continues to grow, household waste has emerged as the leading contributor to environmental pollution, surpassing other waste sources (Tang, D. et al., 2023). Rising living standards and improved community welfare—when not accompanied by adequate waste management infrastructure—can exacerbate the generation of household waste (Jia, Cheng, & Shi, 2021). This trend is further intensified by unsustainable patterns of production and consumption, which are among the key concerns outlined in the 13th Sustainable Development Goal (SDG). A significant increase in household waste, if not managed properly, can result in serious environmental degradation and pose substantial threats to human health (Knickmeyer, 2020). Poor waste management practices can lead to injuries from exposure to radiation or hazardous chemicals, psychological and social issues, chronic non-communicable diseases such as cancer, and communicable diseases caused by biological agents, including worm infestations, diarrhoea, dysentery, and skin irritation (Fadhullah et al., 2022). In contrast, effective household waste management can help reduce

greenhouse gas emissions and support the global goal of achieving carbon neutrality (Wen et al., 2023). According to the United Nations, advancing household waste management is aligned with the 12th SDG, which promotes responsible consumption and production (United Nations SDGs Report, 2023).

Managing household waste effectively in different countries requires diverse and innovative approaches, including the implementation of smart systems. A smart household waste management system can contribute to sustainability by minimizing waste, enhancing public awareness and education, improving economic outcomes, and strengthening information technology infrastructure. These systems rely on the integration of information technology and data to address household waste challenges more efficiently (Anjum et al., 2022). Based on the Integrated Sustainable Waste Management (ISWM) framework, there are eleven key processes involved in waste management: generation, separation, collection, transfer, transport, treatment, disposal, reduction, reuse, recycling, and recovery (Razip et al., 2022). Each of these processes should ideally be supported by smart and integrated technologies to maximize effectiveness.

The primary dimensions identified in this study are used to guide the design of a framework for smart household waste management. In addition to identifying these core dimensions, this research also focuses on waste management processes and the data needed to support them. Mapping these processes is essential for enhancing the performance of smart waste systems (Sallem et al., 2021; Zhou et al., 2021), improving resource allocation (Crome et al., 2023), and facilitating the integration of emerging technologies such as sensors (Nguyen et al., 2021), machine learning algorithms (Namoun et al., 2022), and communication network technologies (Abidin et al., 2022). Similarly, identifying the types of data managed within smart waste systems supports real-time monitoring and decision-making for efficient waste handling (Crome et al., 2023), optimization of waste collection routes (Janela, Mourão, & Pinto, 2022), and the development of Internet of Things (IoT)-based solutions (Kang et al., 2020). The identification of technological dimensions, based on both processes and data, is crucial for implementing an optimized household waste management system in Rajshahi Metropolitan City (RMC).

This review is guided by the following research questions:

RQ 1. What household solid waste (HSW) management processes are currently supported by waste management systems in developing countries?

RQ 2. To what extent environmental awareness and knowledge influence individual waste disposal behaviors?

RQ 3. What are the key factors shaping the development of HSW management systems in developing countries, with a focus on Rajshahi, Bangladesh?

Research Methodology

Systematic Literature Review Design

This study employed a Systematic Literature Review (SLR) following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. The review was designed to explore household waste management processes within the framework of Integrated Sustainable Waste Management (ISWM). As part of the conceptual design, the study first identified the types of household waste management processes, the supporting dimensions necessary for an effective system, and the relevant stakeholders involved in implementation. The resulting framework is considered integrated, as it encompasses all stages of the waste management process and emphasizes system-wide coordination and technological integration.

Keyword Selection and Search Strategy

To ensure comprehensive coverage of the research domain, the author conducted a series of keyword experiments and combinations to determine the most suitable search terms. The inclusion of "solid waste" alongside "household waste" was intentional, allowing for the identification of articles that addressed the broader solid waste context, even if they did not focus exclusively on household waste.

The final keyword string used in the Web of Science database was as follows:

All Fields: "solid waste" AND "solid waste management" AND "household waste" AND "disposal"

All Fields: "developing countries" AND "low-income countries" AND "poverty" AND "subsistence marketplace"

This search yielded 613 articles, which were further refined through screening.

Screening and Selection Process

The document search was conducted using the Web of Science Core Collection on August 31, 2023, and included all available editions and document types. The first round of screening involved reviewing the titles and abstracts of the 613 retrieved articles. Articles were excluded if they focused on unrelated fields such as tropical or infectious diseases, construction, biotechnology, microbiology, meteorology, ethics, or sanitation. Following this, Web of Science's built-in tools—specifically, "Analyze Results" and "Tree Map Chart"—were used to narrow down the selection to 469 articles. A further round of screening was applied to focus solely on articles related to Bangladesh, leading to the exclusion of additional articles from non-relevant domains. This process resulted in a final selection of 145 articles that aligned with the objectives of this review and were deemed suitable for full-text analysis. Figure 1 illustrates the article selection process, detailing the screening steps that reduced the total number of articles from 613 to 145 based on relevance.

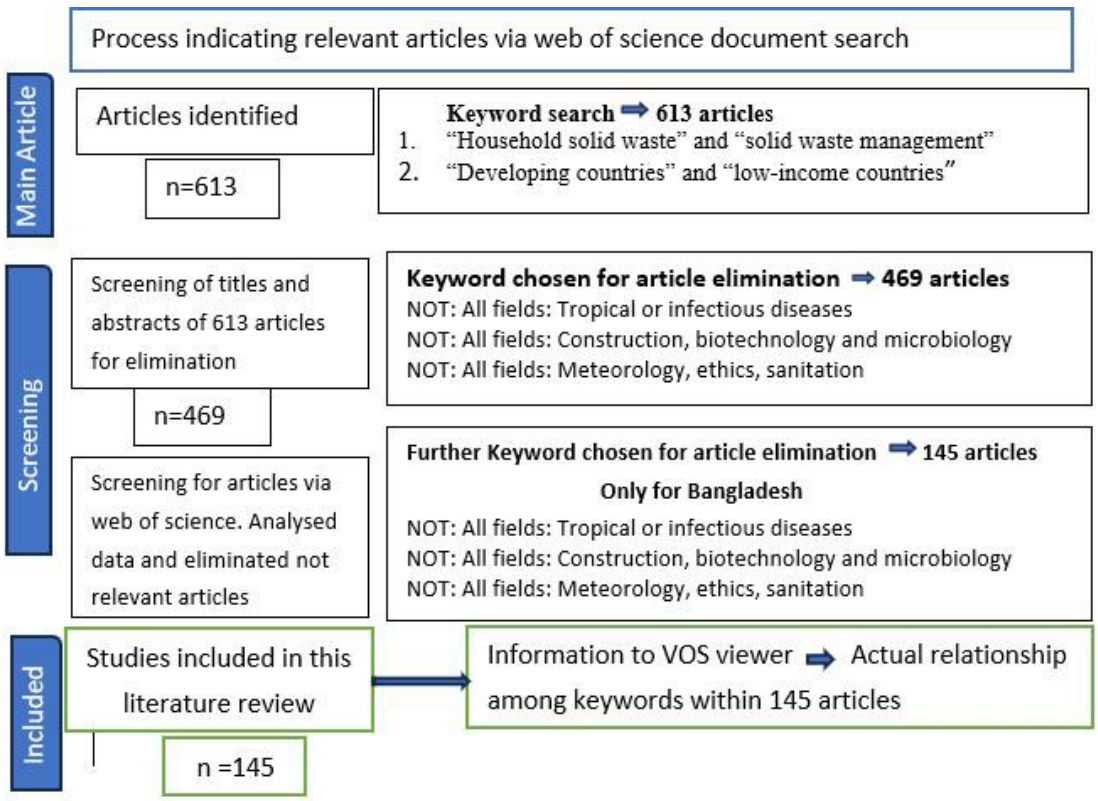

Figure 1. Overview of the document search and selection process using the Web of Science database

Source: Created by the authors based on the systematic search strategy

Data Analysis Using VOSviewer

The 145 selected articles were downloaded from the Web of Science as text files, including full records and cited references. These files were imported into VOSviewer (version 1.6.19) for bibliometric mapping and co-occurrence analysis. During this stage, the "Create a Map Based on Bibliographic Data" option was selected and Co-occurrence Analysis was used as the methodology to identify relationships among frequently appearing keywords within the dataset.

This approach enabled the identification of research trends, topic clusters, and thematic associations, thereby offering a comprehensive overview of the current landscape of household waste management research in developing countries, with a specific focus on Bangladesh.

Network Visualization and Interpretation

The final analysis stage involved generating a network visualization in VOSviewer. This visual representation of the 145 articles allows for an interactive examination of keyword relationships. Items such as management, determinants, and similar terms are displayed with labels and are typically enclosed by circular boundaries. The size of each label and circle reflects the weight of the keyword—frequently occurring terms appear larger and more prominent. The color of each item indicates its inclusion within a thematic cluster. This visualization provides valuable insight into dominant themes and emerging areas of focus in management literature, supporting the analytical depth of this review.

Results

HSW management is a key component of environmental sustainability in developing countries. This review synthesized literature across thematic and regional contexts to identify major challenges, behaviors, and factors shaping effective HSW systems, particularly in relation to the case of Rajshahi, Bangladesh. The findings offer theoretical and practical insights for both researchers and policymakers.

Despite the volume of scholarship, the literature affirms that there is no single, universally applicable solution to HSW management. Instead, strategies must be adapted to fit local demographic profiles, cultural norms, and geographic conditions, all of which significantly shape waste disposal behaviors (Raab et al., 2021b). Transferring practices across contexts without local adaptation remains a persistent challenge in the field.

The results are organized in relation to the three guiding research questions.

RQ1: What HSW management processes are currently supported by waste management systems in developing countries?

Solid waste management systems in developing countries face multifaceted challenges. These include both technical and social limitations. Several studies emphasize the need for community-driven, context-sensitive, and culturally aligned solutions (Borthakur & Singh, 2022; Shyamal et al., 2023). When management systems are misaligned with the behaviors, beliefs, or knowledge of local communities, implementation tends to fail or result in poor adoption. In addition to behavioral and cultural gaps, the literature highlights persistent technical and infrastructural shortcomings. For instance, Halme et al. (2022) and Raab, Salem, and Wagner (2021a) stress the importance of contextual rigor—the need to integrate geographic, socio-demographic, and cultural variables into waste planning. E-waste is a particular area where systems often focus solely on infrastructure without addressing user behavior or social context, further limiting their effectiveness.

RQ2: To what extent do environmental awareness and knowledge influence individual waste disposal behaviors?

Environmental awareness and public knowledge consistently emerge as key drivers of responsible household waste practices. Several studies demonstrate that when individuals understand the environmental risks of improper waste handling—and are aware of best practices—they are more likely to adopt sustainable disposal behaviors (Celestino, Carvalho, & Palma-Oliveira, 2022; Zand, Heir, & Tabrizi, 2020). However, awareness alone is not enough. The literature suggests that education must be paired with supportive infrastructure and practical engagement opportunities. Recommended approaches include public awareness campaigns, educational workshops, and access to basic disposal tools. More interactive strategies—such as repair cafés, clean-up events, and collaboration with local leaders—have proven especially effective (Attiq et al., 2021; Borthakur & Singh, 2022; Farage et al., 2021; Oduro-Appiah, Afful, & Osei-Tutu, 2022; Shyamal et al., 2023). Moreover, the literature calls for an inclusive, multi-sectoral approach to behavioral change. Extending engagement efforts to schools, universities, local businesses, and civil society can promote more widespread community transformation.

RQ3: What are the key factors shaping the development of HSW systems in developing countries, particularly in Rajshahi, Bangladesh?

Several interrelated demographic and environmental factors influence household waste generation and management in developing contexts:

1. **Family Size:** Waste generation is closely linked to the number of household members and family structure. While larger households typically generate more waste, communal consumption practices can reduce per capita waste generation. Studies offer mixed evidence: some support a positive correlation (Trang et al., 2017), while others report a negative relationship (Miezah et al., 2015).
2. **Monthly Income:** Income influences both the volume and composition of waste. Higher-income households tend to generate more non-biodegradable and biodegradable waste due to greater purchasing power (Zhu et al., 2008). However, some studies report that wealthier households produce less organic waste due to more frequent dining out (Qu et al., 2009; Trang et al., 2017). Ogwueleka (2013) further disaggregates waste generation trends across income brackets.
3. **Education Status:** Education plays a dual role. While higher education levels are associated with greater environmental awareness, Qu et al. (2009) found that households with secondary education produced the least waste— suggesting that waste behavior is not always linearly related to education level.
4. **Gender of the Household Head:** Gender-specific differences in waste behavior are not always significant, but some studies identify a slight correlation. Gender-sensitive planning may improve resource targeting and cost-effectiveness (Noufal et al., 2020).
5. **Age of the Household Head:** Some evidence suggests that older adults generate less waste due to modest consumption and greater social responsibility. However, this correlation is inconsistent across studies (Lebersorger & Beigl, 2011).
6. **Housekeeping Practices:** Waste composition is influenced by daily cleaning activities, often performed by women in charge of food preparation and hygiene. Morning cleaning routines frequently lead to mixed disposal of food waste and other household materials in a single bin.
7. **Seasonal and Geographic Variations:** Seasonal changes influence both the type and volume of waste. For instance, warmer weather increases bottled drink consumption, while months with more landscaping (e.g., May–August) result in higher green waste (Armijo de Vega et al., 2008). Geographic context also plays a role: rural areas tend to generate more biodegradable waste but suffer from weak

collection systems, while urban areas produce more plastic and face complex logistical challenges.

8. **Infectious Disease Outbreaks:** Pandemics like COVID-19 have impacted waste generation dramatically. While emissions temporarily declined, the pandemic caused a surge in hazardous household and medical waste, stressing existing systems (Sarkodie & Owusu, 2021).

Discussion

This discussion interprets the main findings from the literature review through behavioral, structural, and contextual lenses. While HSW management in developing countries is often framed as a technical challenge, this review highlights the importance of understanding the socio-economic, behavioral, and spatial dimensions that shape its effectiveness—particularly in urban settings such as Rajshahi.

Structural and Contextual Barriers

Waste management remains one of the key challenges in developing countries, particularly in urban areas, where waste generation is most concentrated and least efficiently managed. In less developed cities, a high percentage of this waste is not reused and ultimately ends up in landfills (Méndez-Lazarte et al., 2023). The lack of adequate infrastructure, irregular service delivery, and insufficient government oversight are recurring obstacles, especially in regions experiencing political or institutional instability like Rajshahi.

Vinti and Vaccari (2022) emphasize that effective waste systems must not ignore rural regions, where nearly half of the global population resides. However, urban systems are often prioritized, leaving rural and peri-urban areas without adequate support, infrastructure, or regulation. The keyword "disposal," which emerged frequently across studies, reflects the widespread reliance on landfilling and dumping as default end-stage management strategies (Shyamal et al., 2023).

System Components and Operational Focus

The prominence of terms such as "collection," "separation," and "household waste" reflects the essential stages of waste handling but also underscores a narrow focus on operational steps. As Kwenda et al. (2022) argue, system effectiveness is shaped by how well these stages are integrated and whether the human and behavioral elements of each step are addressed. The recurring presence of the keyword "systems" suggests a growing focus on standardization and formalization (Kwenda et al., 2022; Massoud et al., 2021; Oduro-Appiah, Afful, & Osei-Tutu, 2022), though this often excludes informal waste actors and community-level dynamics.

Organic Waste and Spatial Constraints

The frequent mention of "food waste" in the literature highlights the urgent need for targeted organic waste management strategies (Attiq et al., 2021). However, organic waste sorting requires space, tools, and infrastructure that are often unavailable in lower-income or informal urban settlements. Méndez-Lazarte et al. (2023) found that both individual attitudes and the availability of physical space significantly influence waste separation behaviors. Similarly, Debrah et al. (2021) observed that while many municipal programs promote education and awareness, they often fail to account for material constraints in the household environment, such as a lack of containers or storage areas for waste sorting.

Knowledge, Environmental Awareness, and Behavioural Change

The role of knowledge is consistently emphasized across studies as a driver of waste management behavior (Celestino, Carvalho, & Palma-Oliveira, 2022; Oduro-Appiah, Afful, & Osei-Tutu, 2022; Zand, Heir, & Tabrizi, 2020). The frequency and co-occurrence of the keyword "knowledge" in the reviewed studies confirm its centrality in shaping household-level practices. However, as Vinti and Vaccari (2022) point out, knowledge alone is insufficient. A lack of tools and enabling environments often results in improper disposal practices, including open dumping and burning. Environmental awareness complements knowledge by shaping the values and motivations behind individual actions (Borthakur & Singh, 2022), but must be reinforced with visible, practical pathways to change.

Willingness to Participate and Pay: Challenging Assumptions

Behavioral insights from the literature challenge long-standing assumptions about low-income communities. Several studies reveal a high degree of willingness to participate in waste initiatives (Ghazali, Tjakraatmadja, & Pratiwi, 2021; Slavík, Dolejš, & Rybová, 2021) and even a willingness to pay for improved services when benefits are tangible and trust is built (Huynh et al., 2022; Massoud et al., 2021). Huynh et al. (2022), in a study from Vietnam, found that residents in less urbanized areas or those unfamiliar with waste sorting were more open to paying for sustainable systems—especially when they perceived health or social improvements. However, these findings should not be generalized. Willingness to invest in sustainable waste practices is often highly context-dependent and shaped by poverty thresholds, cultural norms, and service reliability.

Socioeconomic Barriers and Vulnerability

Despite the potential for engagement, poverty remains a key barrier to sustainable waste practices. Debrah et al. (2021) note that impoverished households often lack the resources, time, or infrastructure to participate fully in formal waste systems. This is further complicated by demographic variables: women often carry a disproportionate burden of household waste management due to their roles in food preparation and cleaning, while older adults may generate less waste due to modest consumption patterns (Noufal et al., 2020; Lebersorger & Beigl, 2011). Several studies highlight the need to understand waste behavior considering income levels, education, and household structure. For example, Qu et al. (2009) and Zhu et al. (2008) found that higher-income households tend to produce more non-biodegradable waste, while Trang et al. (2017) reported that such households may generate less organic waste due to increased dining out. Interestingly, households with secondary education levels produced less waste than those with either primary or advanced education—suggesting that education interacts with consumption patterns in complex ways (Qu et al., 2009).

Summary and Implications

Overall, this literature review reveals that HSW management in developing countries is shaped not only by infrastructure and policy, but also by attitudes, awareness, and social constraints. The interplay between community participation, behavioral drivers, and material conditions must be recognized in both program design and policy implementation. Effective interventions will require more than technical fixes—they must empower communities, address inequalities, and integrate behavioral insights into system-wide planning.

Implications for research & practice

This review offers important insights for both academic and applied domains. Scholars in waste management, sustainability, and behavioral science can draw from its theoretical framework to further explore the socio-behavioral dimensions of waste systems. Policymakers and practitioners will find practical value in the emphasis on community engagement, consumer-focused programs, and culturally responsive education strategies.

Future research should include in-depth case studies, cross-regional comparisons within Rajshahi, and empirical investigations into the links between behavior, awareness, and policy effectiveness. Country-specific and consumer-centric models can further enhance our understanding of localized, effective waste solutions.

Recommendation for evaluation and policy

Building on the findings of this review, several considerations should inform future evaluations of HSW management systems in developing countries. First, it is essential to distinguish between overarching waste management goals— such as those set by legal, policy, or regional frameworks—and the specific objectives of individual evaluations. Clarifying this distinction helps guide methodological decisions and ensures alignment with broader sustainability targets. Second, evaluations should adopt a holistic approach rather than focus solely on isolated indicators like emissions. Comprehensive assessments must account for the environmental, social, and economic dimensions of system performance to capture their full impact and effectiveness. Future research and policy design would also benefit from viewing waste systems as components of a broader throughput economy. This perspective emphasizes that waste is not a final output but part of an ongoing cycle of material and energy flow between markets and ecosystems. As depicted in Figure 2 (modified from Allesch & Brunner, 2014) such a systems-oriented view underscores the complexity and interconnectedness of solid waste management.

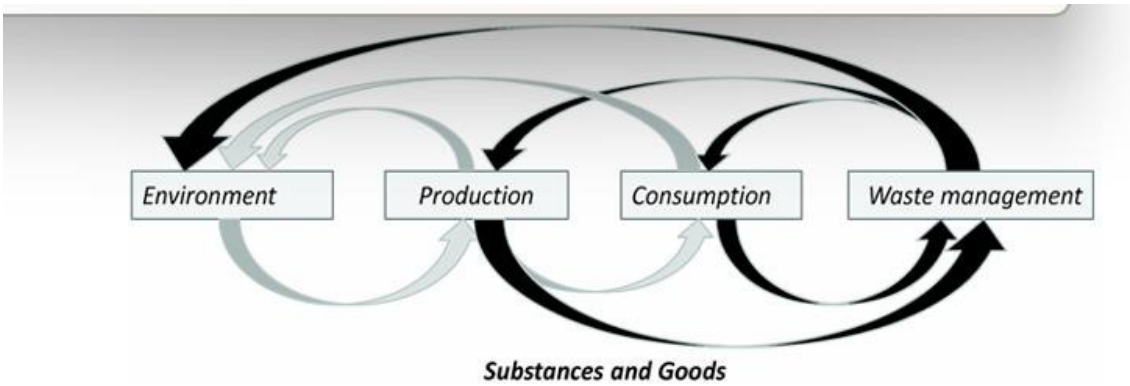

Figure 2. A systems-oriented model of material flow between production, consumption, waste management, and the environment, illustrating the concept of a throughput economy
Source: Modified from Allesch & Brunner (2014)

Lastly, applying the mass balance principle is essential for ensuring evaluation accuracy. Analyses grounded in this principle allow for transparent and traceable assessments of inputs and outputs across waste systems. Methods that overlook this principle risk oversimplifying complex dynamics and generating incomplete or misleading conclusions.

Conclusion

The urgency of strengthening solid waste management in developing countries—particularly among low-income populations—cannot be overstated. This review underscores

the need for behaviorally informed, context-specific approaches to household waste management. It identifies critical system-level barriers in urban settings and calls for community-driven, culturally sensitive solutions. By linking existing research to relevant theoretical frameworks, the review offers insight into how household behaviors can be influenced through effective policy and management interventions. Particular attention is given to Rajshahi Metropolitan City, where ongoing political instability and infrastructural deficiencies continue to hinder progress. Situated at the intersection of waste management, behavioral science, and environmental sustainability, this review bridges theory and practice. It underscores that achieving sustainable behavior change requires context-specific strategies—especially in regions marked by poverty and limited infrastructure. Although solid waste management is not always prioritized in national policy agendas, its environmental and public health implications demand urgent and sustained attention. This study is limited in scope, focusing exclusively on household waste and disposal behaviors in Rajshahi and relying on literature available through the Web of Science database. Nevertheless, this source was selected for its academic rigor and extensive coverage of peer-reviewed research, providing a reliable foundation for analysis. This review lays the groundwork for future interdisciplinary research, technological innovation, and policy integration aimed at transforming household waste into valuable resources, particularly in rapidly urbanizing and underserved areas like Rajshahi.

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