Vol. 17 No. 2 (2026) 1-11

Jurnal Riset
Teknologi Pencegahan Pencemaran
Industri

Journal homepage: https://www.jrtppi.id

Municipal Solid Waste Management Research: A Systematic Literature Review and K-Chart Mapping of Household Behavior, Food Practices, and the Circular Economy

Aswan Munang[1,2], Hari Purnomo[1], Winda Nur Cahyo[1], Imam Djati Widodo[1]*

[1] Faculty Of Industrial Technology, Universitas Islam Indonesia
[2] Industrial Engineering Study Program, Telkom University

ARTICLE INFO

Article history:

Received January 04 2026

Received in revised form March 20, 2026

Accepted April 20, 2026

Available online November 18, 2026

Keywords:

Circular Economy

Food Practices

Household Waste Management

K-Chart

ABSTRACT

Municipal solid waste management faces increasing sustainability challenges driven by rapid urbanization, rising waste generation, changing consumption patterns, and limited institutional and operational capacity, particularly in developing countries. Although previous studies have examined waste management from technical, environmental, behavior, and policy perspectives, the literature remains fragmented in explaining the interactions among circular economy practices, governance, smart technologies, public health, energy recovery, and household behavior. This study systematically maps publication trends, thematic clusters, research gaps, and future research directions in municipal solid waste management by integrating a systematic literature review with K-Chart-based knowledge mapping. Journal articles published between 2015 and 2025 were retrieved from the Scopus database and selected following the PRISMA 2020 guidelines. Of the 118 records initially identified, 30 articles met the inclusion and quality criteria and were included in the final synthesis. The selected studies were analyzed using thematic synthesis and K-Chart mapping to classify research themes, methodological approaches, conceptual relationships, key findings, and research recommendations. Five major thematic clusters were identified: sustainability and circular economy, waste governance, smart waste technology, public health impacts, and refuse-derived fuel and energy recovery. The findings indicate that the literature remains dominated by technical, environmental, operational, and policy-oriented approaches, while the integration of household behavior and food practices remains limited. Additional gaps concern governance resilience, institutional readiness for technology adoption, smart waste analytics, stakeholder coordination, and longitudinal evaluation. This study proposes an integrative conceptual framework linking household waste practices, food-related behavior, governance capacity, technological enablers, circular resource recovery, and sustainability outcomes. The framework provides theoretical and practical guidance for developing adaptive, inclusive, and municipal solid waste management systems.

Keywords: Circular Economy, Food Practices, Household Waste Management, K-Chart

*Correspondence author.
E-mail: imamdjati@uii.ac.id (Imam Djati Widodo)

doi: https://doi.org/10.21771/jrtppi.2026.v17.no2.p1-11
2503-5010/2087-0965© 2026 Jurnal Riset Teknologi Pencegahan Pencemaran Industri-BBSPJPPI (JRTPPI-BBSPJPPI).
This is an open acces article under the CC BY-NC-SA license (https://creativecommons.org/licenses/by-nc-sa/4.0/).
Accreditation number: (Ristekdikti) 158/E/KPT/2021

INTRODUCTION

The high investment costs for waste management facilities in developing countries require innovation strategies and efficient technical implementation of waste management (Hoang & Fogarassy, 2020). Global municipal solid waste generation is projected to increase by approximately 73% from its 2020 level, reaching 3.88 billion tonnes by 2050 as a consequence of population growth, urbanization, economic development, and changing consumption patterns (International Bank for Reconstruction and Development, 2023; Kaza et al., 2018). These trends indicate that waste management can no longer be viewed merely as a technical activity involving collection, transportation, and final disposal. Instead, it must be understood as an integrated system connecting waste-generating activities, community behaviour, public services, technological processes, institutional arrangements, and government policies.

Municipal solid waste is the result of the activities of individuals, groups, micro, small, and medium enterprises, tourist attractions, markets, hotels, and households with a composition of organic and non-organic waste (Sharma & Jain, 2020). In many developing regions, organic matter accounts for approximately 50% of the total composition of household waste (Spoann et al., 2018). The uncontrolled increase in waste production has led to a reduction in the function of final processing sites (TPA) and increased operational costs of waste management (Tsydenova et al., 2018). The community has a positive attitude towards sorting and recycling waste, but knowledge and management practices are still low, so consistent education is needed (Sarker et al., 2024). Furthermore, the government has a dominant role in monitoring and forming regulations to reduce household waste production (Lin & Guan, 2021).

Upstream waste management includes identifying waste sources, source separation, and collection. Facility accessibility, socialization, and information can improve household sorting behavior (Tang et al., 2023). Artificial neural networks (ANN) and geographic information systems (GIS) have also been integrated to improve waste collection systems, optimize transportation routes, reduce travel distance by approximately 10.3 % to 16 %, decrease emissions, and improve collection efficiency by approximately 15.7 % to 19.8 % (Hatamleh et al., 2020). Meanwhile, its implementation in developing countries is very limited due to management budget factors, population density, and economic limitations (Bezama & Agamuthu, 2019).

Education and community participation can support behavioural change by increasing awareness of food waste prevention, source separation, reuse, composting, and recycling (Ferronato & Torretta, 2019). Household food waste accounts for approximately 28.4% to 31.9% of total food waste, exceeding the contribution of the commercial sector (Yu & Jaenicke, 2020). Nevertheless, research on household food practices and food waste remains fragmented across behavioral, operational, and policy clusters (Bravi et al., 2020). Furthermore, recent research developments show that households can take a greater role in sustainable food waste management (Slorach et al., 2020). Thus, food waste is the result of a series of household decisions influenced by habits, knowledge, social values, economic conditions, facilities, and access to waste management services.

Systematic literature review provides transparency in the process of identifying, selecting, evaluating, and synthesizing relevant publications on household waste management, food waste, and food practices. Furthermore, the K-Chart can systematically organize the literature based on the problem context, research object, theoretical perspective, variables, methods, indicators, and expected outcomes. The integration of a systematic literature review and K-Chart analysis results in a more comprehensive identification of theoretical, methodological, and empirical gaps while supporting the formulation of a priority agenda for future research.

Based on these limitations, this study aims this paper aims to (1) analyze research trends; (2) identify research topics; and (3) recommend future research directions on solid waste management. The review emphasizes households as a major source of urban waste, the role of food waste and food practices in waste generation, and the need to integrate behavioral, operational, technological, and governance perspectives.

METHODS

The literature review approach uses a mixed method by integrating a systematic literature review and science mapping analysis. The literature review process uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) as a guideline to ensure the process of searching and screening articles is carried out transparently, systematically, and can be replicated so as to capture knowledge gaps and identify trends in future research studies (Page, McKenzie, et al., 2021). A literature review was used to examine the interrelationships between household waste generation, household behavior, food practices, food waste, the circular economy, governance, and waste management technology.

Science mapping analysis uses K-Charts to visualize detailed illustrations of information and synthesize the results of empirical data extraction. K-Charts provide a pattern for structuring knowledge from the literature into a cognitive mapping scheme, methodological characteristics, interconnections between variables, and identification of knowledge gaps. Therefore, K-Charts are an integrated visualization tool for viewing the broad context of a topic and identifying future research gaps (Cahyo, 2021). Figure 1 explains the PRISMA guidelines.

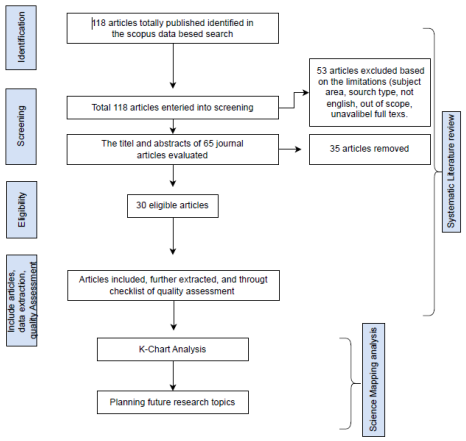


Figure 1. Systematic literature review and science mapping analysis.

Systematic literature review

The systematic literature review uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines as the basic framework in this study. The implementation of PRISMA 2020 to guide the search, selection, and evaluation of data is able to sharpen the systematic review, improve the quality of analysis, increase transparency, data accuracy, and replication (Page, Moher, et al., 2021). Next, the process of analyzing literature data with a thematic synthesis approach to identify topics, concepts, literature gaps, and develop a conceptual model.

Identification.

The literature review identification process uses the Scopus digital database because its main bibliography has a multidisciplinary scope of environmental sciences, engineering, technology, social sciences, economics, public health and public policy (Xiao & Watson, 2017). This digital database has perspectives from several recent journals and publications and is widely considered a comprehensive and reliable data source. Reliance on a single database remains a limitation because relevant publications indexed elsewhere may not be captured.

Screening.

The literature review paper search used the following specific criteria: engineering field of study, article document, journal source, final publication, English language, and year range (2015 – 2025). The search strategy was to divide the topics into three conceptual groups. The first group was about types and sources of waste, the second group was about waste processing processes and systems. The third group was about behavior factors, food practices, governance, technology, and public health. The search string using the Scopus database was TITLE-ABS-KEY ("municipal solid waste" or "urban solid waste" or "household solid waste" or "food waste" or "domestic waste") AND ("waste management" or "waste management system" or "source separation" or "waste segregation" or "circular economy") AND ("household behavior" or "food practices" or "consumption practices" or "technology" or " energy recover") (LIMIT-TO (PUBBYEAR ≥ 2015). Based on the initial search, 118 articles were obtained from Scopus. This identification process ensured that the use of literature in the study had a representative scope and was relevant to the issue of solid waste management.

Eligibility.

The Scopus digital database articles were then thoroughly reviewed to ensure their suitability to the research focus. The review process included evaluation of the title, abstract, research objectives, methodology, systematic review, publication period, study topic, and completeness of the text. Criteria for articles discussed urban, household, domestic, organic, or food waste and addressed at least one relevant analytical dimension, such as behavior, food practices, source sorting, operational systems, circular economy, governance, technology, public health, or energy recovery, and integrated technical and managerial approaches. At this stage, articles that addressed general policy issues without technical relevance, focused on areas other than domestic solid waste, or had methodological limitations were eliminated. Articles that solely discussed industrial, construction, mining, agricultural, electronic, medical, or hazardous waste were excluded if they had no direct relationship to household or urban waste management systems. Table 1 explains the inclusion and exclusion criteria.

Tabel 1. Explain kreteria inclusion dan exclusion.

No	Inclusion criteria	Exclusion criteria
1	Paper or proceeding published in Scopus Index	Books, reviews, short articles, magazine articles,

		paper or proceeding not published in Scopus Index
2	Published from 1 January 2015 to December 2025	Published outside 1 January 2015 to December 2025
3	Available in full text	Unavailable in full text
4	Paper writer in English	Paper not writer in English
5	Articles should address specific word	Articles do not include word combinations
6	Municipal, household, domestic, organic, or food waste	Only discusses industrial, medical, mining, construction, electronic, or agricultural waste without any relation to urban waste.
7	objectives, data, methods, analysis, and results are adequately described	Methodological information is very limited or conclusions are not supported by the results of the analysis.

Include Article, data extraction, and quality assessment.

Articles that meet the eligibility criteria will be included in the inclusion stage as the primary source of analysis. The selected papers cover a variety of methodological approaches, case studies, and system models relevant to household solid waste management. Next, an extraction process is conducted to gather essential information from each article, including the research objectives, study location, time period, methods used, and key findings. This process ensures that the extracted data is consistent and can be systematically compared across studies.

Science mapping review.

The goal of science mapping is to provide a visualization of how the scope of scientific disciplines and research areas is conceptually, intellectually, and socially (Cobo et al., 2011). Through this approach, it can provide an analysis of the patterns of interconnectedness between topics, authors, institutions, and countries so as to visualize the dynamics of scientific development. Next, the science mapping review is presented through a combination of K-Chart analysis. K-Chart analysis is used to identify dominant topic trends, as well as trace the evolution of research themes over time.Thus, the science mapping approach serves not only as an evaluative tool but also as a strategic basis for directing future research agendas.

K-Chat Analysis.

K-Chart analysis is a hierarchical visualization technique used to organize and map research data based on scope, methodology, and key findings. This approach overcomes the limitations of conventional literature reviews by providing a more objective and in-depth representation of research databases (Martinez et al., 2019). K-charts were used to track publication trends over a specific period, classify articles according to inclusion criteria, and map research issues from a general to a specific level.

K-Chart analysis was used to classify and map articles into structured thematic analysis categories. The analysis procedure was carried out in five stages. First, each article was reviewed to identify the main focus of the research, including the object of study, waste management issues, and dominant research orientation. Second, a thematic analysis coding process was conducted based on the research objectives, keywords, methodological approach, key findings, and recommendations for future research. Third, articles sharing thematic analysis characteristics were grouped into broader research clusters. Fourth, research gaps and future research directions were mapped within each cluster to identify unresolved issues, methodological limitations, and new research opportunities. Fifth, the results of the thematic classification and gap mapping were integrated into a conceptual framework. To improve classification reliability, the coding process was iteratively reviewed by comparing the objectives, keywords, findings, and recommendations of each article to be placed in the final thematic cluster.

RESULT AND DISCUSSION

Annual Publication trend.

Annual distribution of the included studies literature review were 30 articles from 2015 to 2025, with an increasing trend of publications in the household waste management sector. The trend in household waste research has become a national and global issue, impacting environmental sustainability. One emerging waste management model is the application of the circular economy concept (Achillas & Vlachokostas, 2025).

Earlier waste-management research was dominated by technical approaches to collection, transportation, and final disposal, with limited integration of social and behavioral factors (Sembiring et al., 2024). This is limited by the perspective of waste management, which accommodates non-technical, social, government, and infrastructure variables within the framework of behavior change in society (Nguyen et al., 2023). **Figure 2** describes the trend in published articles.

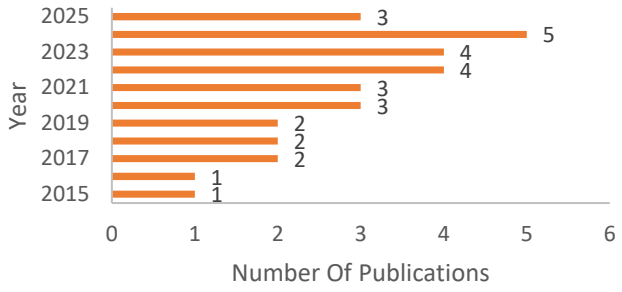


Figure 2. Number of published papers annually trend

Waste management schemes have developed significantly by integrating social and behavior aspects of society into a sustainable system. Community participation, environmental awareness, sorting, and the role of technology are part of sectoral integration in waste management (Shi et al., 2021). Behavioral theories such as the Theory of Planned Behavior and Social Practice Theory are increasingly used to explain how policy and technology interventions translate into household action (Wu et al., 2022).

Journal sources

Article analysis sourced from reputable international journals Waste Management, Journal of Cleaner Production, Resources Conservation and Recycling, and Sustainability covers the fields of environment, engineering and technology, and public policy. Technical and system-efficiency topics remain prominent, whereas social science, culture, household habits, and consumption behavior receive less systematic attention (Aschemann-Witzel et al., 2018). Tabel 2 menjelaskan sintesis 30 artikel review.

Tabel 2. Sintesis 30 artikel review

Author and article title	Focus research
Enhancing sustainable solid waste management through separate source collection,	Source sorting, separate collection, recycling, cost efficiency and community participation
Okin et al. (2024). **Geospatial Analysis of Malaria and Typhoid Prevalence Due to Waste Dumpsite Exposure**	Identification of open dumpsite contamination, access to collection services, malaria, typhoid, and health symptoms.
Mustafa et al. (2025). **Households' expenditures for solid waste management services**	Household expenditure on waste collection and disposal and the influence of socio-economic characteristics
Tang et al. (2022). **Influencing Factors on the Household-Waste-Classification Behavior of Urban Residents**	Household waste classification behavior, rewards-sanctions, education, classification standards, facilities
Costa et al. (2025). **Municipal solid waste management in Portugal using material flow analysis**	Waste streams, reliance on landfills, segregated collection, organic valorization, environmental policy
Tekulu & Islam (2025). **Post-war solid waste management in Adigrat**	Household waste generation, disposal practices, perceptions of city services
Patil & Gidde (2023). **RFID and IoT Enabled Framework to Make Pune City an Eco-friendly Smart City**	Door-to-door collection tracking, waste source identification, RFID, IoT, GIS/GPS, and smart city
Chumo et al. (2025). **Addressing the near absence of formal governance in service provision**	Informal governance of basic services, including waste management, collaboration, monitoring, sanctions, management
Saifi & Jha (2024). **An Overview of Solid Waste Management Practices in Pune, Maharashtra, India**	SWaCH model–Pune Municipal Corporation, informal sector, segregation, collection of plastic and e-waste,
Kokkinos et al. (2025). **Assessing a Pilot Door-to-Door Municipal Collection Program in Greece**	Door-to-door collection of biowaste and recycled materials, purity, contamination, and citizen satisfaction levels.
Joaquim et al. (2025). **Assessing the Potential of a Hybrid Renewable Energy System**	MSW gasification, solar generation, electricity production, energy costs, payback period, and emission reduction.
Tepvarin et al. (2025). **A Stepwise Framework for Prioritizing Blockchain-Enabled Waste Management**	Blockchain for waste tracking, recycling incentives, waste exchange platform, and pay-as-you-throw
Murugan et al. (2023). **Automated home waste segregation and management system**	Automatic sorting of household waste into biodegradable, non-biodegradable, combustible

Nguyen et al. (2023). **Composting Activities in Vietnam The Situation, Problems, and Challenges**	Biodegradable waste, source sorting, composting facility performance, contamination, product quality
Roba et al. (2025). **Domestic solid waste management practices and their determinant factors in Bule Hora town**	Domestic waste management practices, 3 (reduce, reuse, recycle) collection services, institutional conditions, institutional income
Jelonek & Rompalski (2025). **Emission Characteristics During the Co-Firing of Fine Coal and Refuse-Derived Fuel**	Co-firing of coal and RDF, emission characteristics, fuel composition, and fossil fuel substitution.
Madhavaraj & Karthikeyan (2025). **A review of municipal solid waste management and landfills in India.**	Status of India's landfills and MSWM, environmental and health impacts, policies, processing technologies and sustainability
Sumethchotimetha & Sompornpailin (2025). **Sustainable Waste Management Improves the Quality of Industrial RDF Production and Benefits**	MSW/LSW raw material quality, sorting, RDF3 production, calorific value, moisture, chlorine, and efficiency
Li et al. (2023). **The Plastic Age: River Pollution in China from Crop Production and Urbanization**	River macroplastics and microplastics, urbanization, unmanaged solid waste, wastewater systems
Restrepo-Franco et al. (2025). **The vehicle routing problem as applied to residential solid waste collection operations: Systematic literature review**	Vehicle routing, Geographic Information System, exact algorithms, heuristics and metaheuristics, multiobjective routing, uncertainty
Uneven Progress in Circular Economy Practices: Local Government Approaches to Waste Management in Australia. Don et al. (2025).	Household waste services, FOGO, mixed recycling, glass separation, policy, public education and energy
Sierra Puentes et al. (2025). **Using Community-Based Social Marketing to Promote Pro-Environmental Behavior**	Separation and handover of hard-to-manage MSW, psychosocial, structural and institutional barriers
Giraldo-Almario et al. (2024). **Wasteaware adaptation to the context of a Latin American country: evaluation in Cali, Colombia**	MSWM system performance, collection, controlled disposal, recycling, user and worker inclusion and quality
Bhave & Thakkar (2019). **Waste management strategies for mini metro cities**	Weaknesses of municipal MSW systems, stakeholder coordination, technology
Akther et al. (2024) **Why do cities in the global South pursue waste incineration rather than source segregation**	Incineration versus source segregation decisions, institutional and financial capacity and the politics of technology
Noman et al. (2023). **Assessment of municipal solid waste from households in Khulna city**	Household waste generation and composition, variation by income, source sorting and leakage
Miezah et al. (2015) **Municipal solid waste characterization and quantification as a measure towards effective**	National generation rates, household waste composition, regional and socio-economic variations and potential
Saeedi et al. (2023) **Smart Cities and Households' Recyclable Waste Management: The Case of Jeddah**	Household participation in the collection, sorting and delivery of recyclable waste and technological support
Boonthavornsatien & Wiwattanadate (2019). **Sustainable Transition Models for Municipal Solid Waste Management**	Mechanical Biological Treatment facility capacity transition, RDF production, material recovery, financial feasibility, and sensitivity
Kushwah et al. (2023). **An empirical investigation of**	Drivers and inhibitors of household waste sorting intentions, including

household's waste separation intention	environmental concerns and guilt

Table 2 describes 30 research articles on urban waste management, dominated by local case studies, secondary data analysis, waste characterization, simulations, and technology applications. Priority studies are developed in the areas of environmental pollution, public policy, governance, behavior science, industrial engineering, information technology, and energy. Intersectoral integration is still limited because behavior studies are rare and not supported by actual operational data; furthermore, technology studies do not consider institutional readiness and community acceptance. Household food practices, domestic role division, trust in services, and the welfare of informal workers are rarely used variables. Within developing countries, these explanatory results illustrate that modernizing waste management does not rely solely on technology but must also begin with data strengthening, source sorting, service reliability, financing, institutional capacity, and informal sector integration. Future research should use longitudinal and intervention-based designs that link household behavior, service operations, technology, governance, and economic, environmental, and health impacts within an adaptive and contextual systems framework. **Table 3**. Research topic clusters and journal sources.

Table 3. Research topic clusters and journal sources.

No	Cluster	Main Topics	Percentage (%)
1	Sustainability & Circular Economy	Circular economy, recycling, composting, material flow analysis, sustainability indicators	8 (26.67)
2	Waste Governance	Governance, waste policy, institutional capacity, informal sector, municipal management	7 (23.33)
3	Smart Waste Technology	Blockchain, IoT, RFID, AI sorting, vehicle routing optimization	5 (16.67)
4	Public Health Impact	Disease exposure, sanitation, environmental health, urban pollution, waste-related illness	5 (16.67)
5	RDF & Energy Recovery	RDF production, gasification, waste-to-energy, emission reduction, alternative fuel systems	5 (16.67)
	Amount		100

Table 3 illustrates the research scope, dominated by environmental and circular economic issues in waste management, accounting for 26.67% of the total articles. Furthermore, waste management, the role of regulation, and supporting infrastructure account for 23.33% of publications, indicating increasing attention to sustainability and resource efficiency (Kirchherr et al., 2017). However, overall, approaches tend to focus on macro systems and have not explored household consumption behavior much.

Engineering and technology contributed significantly, at 16.7%, with a focus on innovation and efficiency in waste management systems. However, the effectiveness of technology is highly dependent on infrastructure and community behavior patterns. In contrast, contributions from social, health, and policy sectors were relatively lower, each below 16.7%. This finding illustrates a lack of education regarding behavior aspects and policy implementation. Consumption behavior, particularly related to food waste, should play a significant role in household waste generation (Stancu et al., 2016).

Thematic Classification Using K-Chart

Thematic Classification K-Chart analysis is an analytical approach that integrates and maps conceptual relationships between the main themes of international articles related to municipal solid waste management (MSWM). The combination of a Systematic Literature Review (SLR) and Thematic Classification K-Chart in the waste management research theme can identify five main clusters: Sustainability and Circular Economy, Waste Governance, Smart Waste Technology, Public Health Impact, and RDF and Energy Recovery. The results of the classification of themes on sustainability and circular economy are priorities in the literature, particularly related to recycling systems, composting, material flow analysis, and resource recovery (Costa et al., 2025). The application of technology, with the development of smart waste management based on blockchain, IoT, RFID, and AI, is starting to be developed as an effort to increase the efficiency of waste collection, sorting, and real-time monitoring (Padilla-Vento & Soria, 2025).

Figure 3 shows the results of the classification of research themes using K-charts.

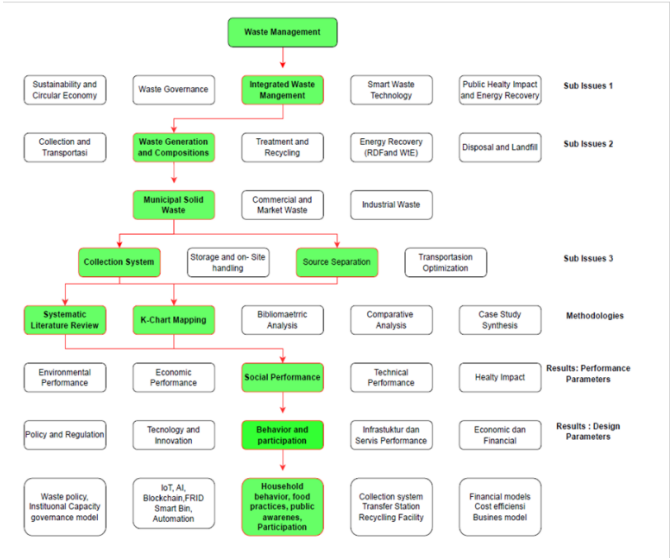


Figure 3. Results theme classification using K-Chart

The results of the Thematic Classification K-Chart visualize the role of technology that influences the success of waste management systems, but can be influenced by institutional governance, community participation, and household behavior. Various studies confirm that source separation, household waste management, and community participation are key elements in increasing the effectiveness of recycling and reducing urban waste (Aryal & Adhikary, 2024). Furthermore, a literature synthesis shows a research gap in the integration of food practices, particularly the relationship between food consumption behavior, food waste generation, and the circular economy in the context of household waste management. The research pattern focuses on the technical aspects of waste management and has not integrated the dimensions of food consumption behavior and household lifestyle changes longitudinally (Mustafa et al., 2025). Furthermore, studies on the integration of governance resilience, public health, and AI-based waste analytics are still very limited and tend to be partial. Therefore, the Thematic Classification K-Chart contributes conceptually and builds a multidisciplinary, adaptive framework that is oriented towards the integration of sustainability, governance, smart technology, and sustainable household behavior in supporting a resilient system. Furthermore, the Thematic Classification K-Chart serves as a classification tool and a tool for building an analytical framework to identify critical gaps and direct research towards an integrative approach based on behavior, technology, and policy simultaneously (Zhang et al., 2019).

Research Gap Analysis.

Across the 30 studies, municipal solid waste management research remains dominated by local case studies and cross-sectional designs. Consequently, the long-term effects of policy implementation, behavioral change, and system adaptation remain insufficiently understood. Smart waste technologies such as blockchain, IoT, RFID, and AI are frequently examined at conceptual, simulation, prototype, or pilot scales rather than through sustained field implementation (Fang et al., 2023).

A key theme gap in the systematic literature review is the weak integration between governance systems, household waste management, public health aspects, and sustainability resilience frameworks. Household research continues to emphasize collection and processing, while changes in food practices, sustainable consumption, and household food management receive limited multidisciplinary and longitudinal attention (Tong et al., 2023). Therefore, future research requires an integrated approach to household waste management, food practices, adaptive governance, smart technology, and a public health perspective to support a more sustainable urban waste management system.

Conceptual integration framework.

The SLR and K-Chart-based integration framework demonstrates that interconnected household practices, food-related behavior, institutional governance, smart technology, community participation, and circular resource utilization shape municipal solid waste management. Source separation, community engagement, resource recovery, and technology adoption emerge as key elements of resilient waste management systems (Lou et al., 2020). However, the literature remains fragmented in linking household food practices with circular economy strategies and in simultaneously integrating governance resilience, public health, AI-based waste analytics, and sustainable behavior. The proposed framework therefore provides a conceptual basis for developing more adaptive, multidisciplinary, and sustainable municipal solid waste management systems, particularly in developing-country contexts.

Discussion

Sustainability Transition and Circular Economy

The transition from conventional collect-transport-dispose systems toward resource recovery and circular economy models has become a central direction in municipal solid waste management. Evidence from Australia, Portugal, and Thailand shows that circular economy policies, material flow analysis, recycling infrastructure, and RDF-based energy

recovery can reduce landfill dependence, improve resource efficiency, and support low-carbon transitions (Don et al., 2025). However, the effectiveness of circular economy implementation depends strongly on source separation, community participation, and institutional support (Munoz et al., 2024). while evidence on its long-term performance remains limited, particularly in developing countries facing infrastructure and governance constraints (Giraldo-Almario et al., 2024). Future research should therefore evaluate circular economy strategies as integrated socio-technical systems that simultaneously address waste reduction, resource recovery, institutional capacity, and sustainable value creation.

Waste Governance and Institutional Capacity

Governance and institutional capacity are critical determinants of effective municipal solid waste management, particularly in developing countries where fragmented governance, weak coordination, limited financing, inadequate public services, and poor regulatory enforcement constrain system performance (Tekulu & Islam, 2025). These challenges are further intensified by the limited integration of informal waste workers, who play a substantial role in collection and recycling but often lack institutional recognition and social protection. Sustainable waste management therefore depends on institutional readiness, cross-sector coordination, reliable financing, regulatory capacity, and stronger integration with urban planning, public health, and community participation (Mustafa et al., 2025). Furthermore, strengthening governance resilience, multi-sector collaboration, and developing circular economy-based policies are priorities in supporting a more sustainable and inclusive waste management system.

Household Waste Management and Food Practices

Household waste management is strongly influenced by consumption patterns, source-separation practices, socio-economic conditions, access to collection services, and environmental awareness, all of which shape the effectiveness of municipal solid waste management systems (Romano & Masserini, 2023). Evidence from developing countries also indicates that inadequate infrastructure and limited awareness contribute to open dumping and burning, while social norms, community participation, and environmental awareness can strengthen waste segregation and recycling practices. In this context, food practices represent an important but insufficiently explored dimension because household decisions related to food consumption and disposal directly affect organic waste generation, landfill dependence, and broader sustainability outcomes. Future research should therefore integrate household food practices, behavioral change, circular economy principles, and waste governance within a multidisciplinary framework to support more resilient and sustainable municipal waste management systems.

Smart Waste Technology and Digital Innovation

Digital technologies are increasingly shaping modern municipal solid waste management through applications such as AI-based sorting, blockchain, RFID, IoT, GIS, and vehicle routing optimization, which can improve collection efficiency, traceability, real-time monitoring, and operational performance (Saifi & Jha, 2024). The collaborative application of Geographic Information System (GIS) technology in vehicle routing optimization, machine learning, and optimization algorithms can improve time efficiency, collection routes, and energy consumption in transportation (Abdella Ahmed et al., 2022).

However, most smart waste technologies remain at the conceptual, simulation, or pilot stage, with large-scale implementation constrained by digital infrastructure readiness, investment requirements, data governance, institutional capacity, and limited integration with public participation and governance systems (Olawade et al., 2024). The direction of future research development is the implementation and development of AI-based waste analytics databases and predictive waste generation in supporting smart cities.

K-Chart and Conceptual Integration Framework

K-Chart analysis classified municipal solid waste management research into five major clusters: sustainability and circular economy, waste governance, smart waste technology, public health impacts, and RDF and energy recovery, with sustainability and circular economy emerging as the dominant theme, followed by governance and smart waste technology (Najafi et al., 2024). The synthesis indicates that contemporary municipal solid waste management is increasingly multidisciplinary, integrating environmental, social, technological, economic, and public health dimensions within a broader sustainability framework. Building on these findings, the conceptual integration framework links urbanization, household waste generation, food practices, governance capacity, smart technology adoption, circular economy strategies, and sustainability outcomes, highlighting that effective waste management depends not only on technical interventions but also on community participation, household behavior, institutional readiness, and governance resilience.

CONCLUSION

This systematic review and K-Chart analysis identified five major clusters within municipal solid waste management research: sustainability and circular economy, waste governance, smart waste technology, public health impacts, and RDF and energy recovery. Sustainability and circular economy constituted the largest cluster, followed by waste governance. Nevertheless, the literature remains dominated by locally bounded, technical, operational, and cross-sectional studies. Household food practices, longitudinal behavior change, institutional readiness, governance resilience, and interactions between household behavior and service performance remain insufficiently integrated.

The principal theoretical contribution of this study is an integrative framework linking household food and waste practices with waste generation, source separation, service operations, governance capacity, technological adoption, circular resource recovery, and sustainability outcomes. For practitioners, the findings indicate that digital technologies and energy-recovery systems should not be implemented as stand-alone interventions. Their effectiveness depends on reliable collection services, human-resource capacity, financing, community trust, source separation, and formal-informal sector coordination.

This review is limited by its reliance on a single database, English-language publications, the selected time horizon, and interpretive thematic classification. Future research should employ longitudinal and intervention-based designs, direct waste measurement, multi-source operational data, AI-based analytics with field validation, and comparative studies across developing-country contexts.

ACKNOWLEDGMENT

The author would like to express his gratitude to the promoter and co-promoter for their guidance, constructive critical input, and motivation, and appreciation to the Universitas Islam Indonesia for providing important facilities to conduct the research

References

Abdella Ahmed, A. K., Ibraheem, A. M., & Abd-Ellah, M. K. (2022). Forecasting of municipal solid waste multi-classification by using time-series deep learning depending on the living standard. Results in Engineering, 16. https://doi.org/10.1016/j.rineng.2022.100655

Achillas, C., & Vlachokostas, C. (2025). Integrated Waste Management in the Circular Economy Era: Insights from Research and Practice. In Energies (Vol. 18, Number 3). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/en18030728

Aryal, M., & Adhikary, S. (2024). Solid waste management practices and challenges in Besisahar municipality, Nepal. PLoS ONE, 19(3 March). https://doi.org/10.1371/journal.pone.0292758

Aschemann-Witzel, J., Giménez, A., & Ares, G. (2018). Consumer in-store choice of suboptimal food to avoid food waste: The role of food category, communication and perception of quality dimensions. Food Quality and Preference, 68, 29–39. https://doi.org/10.1016/j.foodqual.2018.01.020

Bezama, A., & Agamuthu, P. (2019). Addressing the big issues in waste management. In Waste Management and Research (Vol. 37, Number 1_suppl, pp. 1–3). SAGE Publications Ltd. https://doi.org/10.1177/0734242X19825733

Bravi, L., Francioni, B., Murmura, F., & Savelli, E. (2020). Factors affecting household food waste among young consumers and actions to prevent it. A comparison among UK, Spain and Italy. Resources, Conservation and Recycling, 153. https://doi.org/10.1016/j.resconrec.2019.104586

Cahyo, W. N. (2021). Finding Novelty of Research with Systematic Literature Mapping (SLM). Journal of Physics: Conference Series, 1764(1). https://doi.org/10.1088/1742-6596/1764/1/012186

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. Journal of the American Society for Information Science and Technology, 62(7), 1382–1402. https://doi.org/10.1002/asi.21525

Costa, E., Oshita, K., & Takaoka, M. (2025). Municipal solid waste management in Portugal using material flow analysis: regional assessment. Journal of Material Cycles and Waste Management, 27(5), 3238–3251. https://doi.org/10.1007/s10163-025-02279-4

Don, K., Chakraborty, A., Harrison, T., & Sandhu, H. (2025). Uneven Progress in Circular Economy Practices: Local Government Approaches to Waste Management in Australia. Sustainability (Switzerland), 17(22). https://doi.org/10.3390/su172210177

Fang, B., Yu, J., Chen, Z., Osman, A. I., Farghali, M., Ihara, I., Hamza, E. H., Rooney, D. W., & Yap, P. S. (2023). Artificial intelligence for waste management in smart cities: a review. In Environmental Chemistry Letters (Vol. 21, Number 4, pp. 1959–1989). Springer Science

and Business Media Deutschland GmbH. https://doi.org/10.1007/s10311-023-01604-3

Ferronato, N., & Torretta, V. (2019). Waste mismanagement in developing countries: A review of global issues. International Journal of Environmental Research and Public Health, 16(6). https://doi.org/10.3390/ijerph16061060

Giraldo-Almario, I., Rueda-Saa, G., & Uribe-Ceballos, J. R. (2024). Wasteaware adaptation to the context of a Latin American country: evaluation of the municipal solid waste management in Cali, Colombia. Journal of Material Cycles and Waste Management, 26(2), 908–922. https://doi.org/10.1007/s10163-023-01868-5

Hatamleh, R. I., Jamhawi, M. M., Al-Kofahi, S. D., & Hijazi, H. (2020). The Use of a GIS System as a Decision Support Tool for Municipal Solid Waste Management Planning: The Case Study of Al Nuzha District, Irbid, Jordan. Procedia Manufacturing, 44, 189–196. https://doi.org/10.1016/j.promfg.2020.02.221

Hoang, N. H., & Fogarassy, C. (2020). Sustainability evaluation of municipal solid waste management system for hanoi (Vietnam)-why to choose the "waste-to-energy" concept. Sustainability (Switzerland), 12(3). https://doi.org/10.3390/su12031085

International Bank for Reconstruction and Development. (2023). Solid Waste Management A Compendium of Cases. www.worldbank.org

Kaza, S., Yao, L., Bhada-Tata, P., & Woerden, F. Van. (2018). What a Waste 2.0 A Global Snapshot of Solid Waste Management to 2050 Overview. https://doi.org/10.1596/978-1-4648-1329-0

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. In Resources, Conservation and Recycling (Vol. 127, pp. 221–232). Elsevier B.V. https://doi.org/10.1016/j.resconrec.2017.09.005

Lin, B., & Guan, C. (2021). Determinants of household food waste reduction intention in China: The role of perceived government control. Journal of Environmental Management, 299. https://doi.org/10.1016/j.jenvman.2021.113577

Lou, T., Wang, D., Chen, H., & Niu, D. (2020). Different perceptions of belief: Predicting household solid waste separation behavior of urban and rural residents in China. Sustainability (Switzerland), 12(18). https://doi.org/10.3390/SU12187778

Martinez, P., Al-Hussein, M., & Ahmad, R. (2019). A scientometric analysis and critical review of computer vision applications for construction. In Automation in Construction (Vol. 107). Elsevier B.V. https://doi.org/10.1016/j.autcon.2019.102947

Munoz, S., Hosseini, M. R., & Crawford, R. H. (2024). Towards a holistic assessment of circular economy strategies: The 9R circularity index. Sustainable Production and Consumption, 47, 400–412. https://doi.org/10.1016/j.spc.2024.04.015

Mustafa, G., Hayat, N., Alotaibi, B. A., & Traore, A. (2025). Households' expenditures for solid waste management services: Influencing factors and deep insight. PLOS ONE, 20(6 June). https://doi.org/10.1371/journal.pone.0324085

Najafi, S., Khosravani, F., Yousefi, M., Jandaghi, J., Valizadeh, B., & Torkashvand, J. (2024). Development of municipal solid waste management guidelines in biological crisis based on international experiences and considering local techno-economic characteristics. Results in Engineering, 22. https://doi.org/10.1016/j.rineng.2024.102052

Nguyen, A. T., Nguyen, N., Phung, P., & Yến-Khanh, N. (2023). Residents' waste management practices in a developing country: A social practice theory analysis. Environmental Challenges, 13. https://doi.org/10.1016/j.envc.2023.100770

Olawade, D. B., Fapohunda, O., Wada, O. Z., Usman, S. O., Ige, A. O., Ajisafe, O., & Oladapo, B. I. (2024). Smart waste management: A paradigm shift enabled by artificial intelligence. Waste Management Bulletin, 2(2), 244–263. https://doi.org/10.1016/j.wmb.2024.05.001

Padilla-Vento, J. L., & Soria, J. J. (2025). Statistical approach for the evaluation of household solid waste generation in Peruvian households: 2014–2021. Frontiers in Applied Mathematics and Statistics, 11. https://doi.org/10.3389/fams.2025.1498513

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. International Journal of Surgery, 88. https://doi.org/10.1016/j.ijsu.2021.105906

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., Mcdonald, S., …

Mckenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. The BMJ, 372. https://doi.org/10.1136/bmj.n160

Romano, G., & Masserini, L. (2023). Pay-as-you-throw tariff and sustainable urban waste management: An empirical analysis of relevant effects. Journal of Environmental Management, 347. https://doi.org/10.1016/j.jenvman.2023.119211

Saifi, N., & Jha, B. (2024). An Overview of Solid Waste Management Practices in Pune, Maharashtra, India. Nature Environment and Pollution Technology, 23(2), 923–934. https://doi.org/10.46488/NEPT.2024.v23i02.027

Sarker, A., Baul, T. K., Nath, T. K., Karmakar, S., & Paul, A. (2024). Household solid waste management in a recently established municipality of Bangladesh: Prevailing practices, residents' perceptions, attitude and awareness. World Development Sustainability, 4. https://doi.org/10.1016/j.wds.2023.100120

Sembiring, E., Fenitra, R. M., Dangkua, A. R., Khoeriyah, Z. B. Al, Van Der Laan, A. Z., Fan, Y., Ceschin, F., & Jobling, S. (2024). Improving household waste management in Indonesia: A mixed-methods approach for waste Sorting. Cleaner Waste Systems, 9. https://doi.org/10.1016/j.clwas.2024.100185

Sharma, K. D., & Jain, S. (2020). Municipal solid waste generation, composition, and management: the global scenario. Social Responsibility Journal, 16(6), 917–948. https://doi.org/10.1108/SRJ-06-2019-0210

Shi, J. gang, Xu, K., Si, H., Song, L., & Duan, K. (2021). Investigating intention and behaviour towards sorting household waste in Chinese rural and urban–rural integration areas. Journal of Cleaner Production, 298. https://doi.org/10.1016/j.jclepro.2021.126827

Slorach, P. C., Jeswani, H. K., Cuéllar-Franca, R., & Azapagic, A. (2020). Assessing the economic and environmental sustainability of household food waste management in the UK: Current situation and future scenarios. Science of the Total Environment, 710. https://doi.org/10.1016/j.scitotenv.2019.135580

Spoann, V., Fujiwara, T., Seng, B., & Lay, C. (2018). Municipal solid waste management: Constraints and opportunities to improve capacity of local government authorities of Phnom Penh Capital. Waste Management and Research, 36(10), 985–992. https://doi.org/10.1177/0734242x18785722

Stancu, V., Haugaard, P., & Lähteenmäki, L. (2016). Determinants of consumer food waste behaviour: Two routes to food waste. Appetite, 96, 7–17. https://doi.org/10.1016/j.appet.2015.08.025

Tang, D., Cai, X., Nketiah, E., Adjei, M., Adu-Gyamfi, G., & Obuobi, B. (2023). Separate your waste: A comprehensive conceptual framework investigating residents' intention to adopt household waste separation. Sustainable Production and Consumption, 39, 216–229. https://doi.org/10.1016/j.spc.2023.05.020

Tekulu, F. B., & Islam, Z. (2025). Post-war solid waste management in Adigrat, Ethiopia. Asian Journal of Water, Environment and Pollution, 22(4), 18–27. https://doi.org/10.36922/AJWEP025090061

Tong, X., Yu, H., Han, L., Liu, T., Dong, L., Zisopoulos, F., Steuer, B., & de Jong, M. (2023). Exploring business models for carbon emission reduction via post-consumer recycling infrastructures in Beijing: An agent-based modelling approach. Resources, Conservation and Recycling, 188. https://doi.org/10.1016/j.resconrec.2022.106666

Tsydenova, N., Morillas, A. V., & Salas, A. A. C. (2018). Sustainability assessment of waste management system for mexico city (Mexico)—based on analytic hierarchy process. Recycling, 3(3). https://doi.org/10.3390/recycling3030045

Wu, L., Zhu, Y., & Zhai, J. (2022). Understanding Waste Management Behavior Among University Students in China: Environmental Knowledge, Personal Norms, and the Theory of Planned Behavior. Frontiers in Psychology, 12. https://doi.org/10.3389/fpsyg.2021.771723

Xiao, Y., & Watson, M. (2017). Guidance on Conducting a Systematic Literature Review. In Journal of Planning Education and Research (Vol. 39, Number 1, pp. 1–20). Journal of Planning Education and Research. https://doi.org/10.1177/0739456X17723971

Yu, Y., & Jaenicke, E. C. (2020). Estimating food waste as household production inefficiency. https://doi.org/10.1111/ajae.12036

Zhang, B., Lai, K. hung, Wang, B., & Wang, Z. (2019). From intention to action: How do personal attitudes, facilities accessibility, and government stimulus matter for household waste sorting? Journal of Environmental Management, 233, 447–458. https://doi.org/10.1016/j.jenvman.2018.12.059