



Governing the Solid Waste Management System: A Thematic Analysis of Literature on Circular Economy

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Abstract

Background: Modernization induced ever increasing consumption and priority for affluence over environmental conservation have globally increased municipal solid waste and authorities are challenged to its successful management. However, these wastes often end at the landfill, representing can be valuable resource of Circular Economy.

Purpose: This paper addresses the systemic failure of solid waste management system, in terms of Circular Economy.

Design/methodology/approach: The results are based on systematic reviews of 43 peer-reviewed, open access articles published between 2015 to 2025. At first, we identified and sorted articles meeting inclusion criteria, followed by reviewing and open coding and axial coding afterwards, which led to code-grouping, and developing of six themes: governance and policies, methodologies, strategies, context, environmental impacts, and challenges and barriers.

Findings: The regulatory gaps such as institutionalism and path dependency have created institutional resistance in Circular Economy. The exclusion of informal waste actors has limited social equity and operational efficiency of the system. Furthermore, while Life Cycle Assessment dominates methodological approaches in circular economy literature, it warrants urgent integration of social dimensions. Achieving systemic circularity is attached to the Integrated Sustainability Assessment. However, methodological fragmentation of meso-level quantitative tools such as Life Cycle Assessment and Life Cycle Costing, caused failure in achieving holistic integration of stakeholders and accurate evaluation of the complex trade-offs such as environmental, economic, and social costs on poor practice of circular economy.

Conclusion: Structural impediments in solid waste management and material recovery are hindering the effective operationalization of Circular Economy principles, particularly in the Global South. While effective Waste to Energy strategy is prevailing in the North, it has several negative consequences in environment and in material recovery. Therefore, this paper asks to develop and implement a detailed roadmap for structural reform in solid waste governance that emphasizes Circular Economy.

Keywords: Environmental impacts, global south, life cycle sustainability, material recovery, policy-practice gap, zero-waste city (ZWC)

1. Introduction

Modernization, urbanization, and unprecedented economic growth since the Industrial Revolution have created an existential threat to planetary boundaries (Ghisellini et al., 2016). At the nexus of this crisis, the management of Municipal Solid Waste (MSW) is critical due to ever increasing amount of waste required to be dumped. The United Nations Environment Programme projects that global annual waste generation will increase by over 70% by 2050, reaching 3.40 billion tonnes from 2.01 billion tonnes in 2016 (UNEP, 2018). This escalation is not merely a logistical problem of disposal; rather, it represents a fundamental failure of design, consumption, and governance systems since disposal of valuable resource ignoring the significance of circular economy is costly, for both economy and environment.

The environmental impacts of MSW are profound and multifaceted. Landfilling has been a major source of methane emissions, surpassing the contribution of carbon dioxide to global warming over a short period (Jawjit et al., 2025; Madden et al., 2023). Studies demonstrate that improper waste management led to pervasive pollution of both marine and terrestrial ecosystems, directly impacting on biodiversity and human health (Zhou et al., 2022). Despite these wastes represent valuable materials, and the cost of extraction and refinement of finite virgin resources and fuels is costly, reintegrating discarded materials into the economic system, termed as the Circular Economy (CE), is economically optimal strategy.

The CE is an emerging regenerative alternative and represents a principal shift in the resource supply system. The fundamental principle of the circular economy is keeping products and materials in use while regenerating natural systems and decoupling economic activity from resource consumption and waste generation (Ellen MacArthur Foundation, 2021). In this context, CE represents a transformation beyond recycling, including upcycling strategies such as product design for longevity and recyclability, as well as advanced downcycling approaches such as Waste-to-Energy (WtE) conversion and Chemical Feedstock Recovery (CFR) (Ajwani-Ramchandani & Bhattacharya, 2022). The relevance of CE for modern systems is well recognized, as three Sustainable Development Goals (SDGs) such as SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) are directly linked to CE. Nevertheless, progress toward CE has encountered numerous challenges.

Prevailing literature demonstrates two distinct yet interconnected forms of fragmentation in solid waste management (SWM) governance: the gap between policy prescriptions for CE goals and the reality of methodological and institutional capacity for implementation. Policy landscapes often ignore regulatory barriers and gaps, compromising effective execution (Durgekar, 2016). Existing policies failure and systemic constrains of SWM infrastructure prioritize material destruction over circularity or material recovery. For instance, large-scale incineration facilities built under long-term financing commitments and power purchase agreements require high volumes of mixed waste to maintain financial viability (Malinauskaite et al., 2017). This requirement fundamentally contradicts CE principles of source reduction and high-quality material separation, creating a cycle in which policy prioritizes Waste-to-Energy (WtE) technologies over higher-order circularity principles (Jensen & Olsen, 2023). Furthermore, the livelihoods of informal waste pickers, the critical actors in CE and MSW systems, particularly in the Global South, have also been compromised in various SWM governance system (Pandey, 2008; Scheinberg, 2011). Informal waste pickers operate without formal recognition, social protection, or integration into official waste management systems (Pandey, 2004/05; Wilson et al., 2006). This exclusion causes both social inequity, occupational health problems, and inefficiency within SWM systems (Pandey, 2004). Nevertheless, these actors possess valuable knowledge and has established collection networks that could significantly enhance formal recycling systems if properly integrated (Campitelli et al., 2023).

The literature indicates numerous gaps in SWM knowledge from material recovery perspectives. While tools such as Life Cycle Assessment (LCA) are widely used to evaluate environmental performance, the field lacks comprehensive integration of sustainability assessment frameworks that would simultaneously address environmental, economic, and social dimensions (Huppes & Ishikawa, 2005). Existing models largely assess environmental or economic outcomes in isolation, failing to incorporate vital social

dimensions required for sustainable decision-making (Ceraso & Cesaro, 2024). As a result, data-deficient policy decisions often lead to “burden shifting,” rather than reducing adverse outcomes or having a larger social cost. As current state of SWM–CE implementation is characterized by institutional ambiguity and analytical insufficiency, a lack of a clear understanding of CE governance and necessary methodological advancements, may limit CE, even if their policy adoption, to an aspirational label rather than a systemic solution (Bocken et al., 2019). Furthermore, existing literature indicated isolated interventions or singular determinants (Ibarra Vega & Bautista-Rodriguez, 2024) or remains confined to specific disciplinary perspectives (Lieder & Rashid, 2016). Moreover, geographic bias toward either developed or developing contexts limits comparative insights (Velis et al., 2018). Therefore, it is observed that there lacks synthesized frameworks that move from individual interventions to overarching systemic transformation for CE in SWM. Addressing these gaps, this paper undertakes a systematic review to synthesize the state-of-the-art literature on governance and methodological frameworks so effective CE policy, particularly for the global south, who are yet to invest in costly WtE model, could be suggested to improve the lives of thousands of urban poor whose livelihoods rely on circular economy attached to solid waste management.

2. Theoretical Foundation and Empirical Observation

2.1 Theoretical Foundation

This paper uses several concepts and theories of SWM in relation to circular economy. The Circular Economy (CE) is the primary one that is defined as a systemic approach to economic development from waste-economy, i.e., designing out waste, keeping materials in use at their highest value for as long as possible, and regenerating natural systems (Ellen MacArthur Foundation, 2021). This approach moves beyond the traditional linear approach of “take-make-dispose” and embraces a hierarchical cascade of ‘R’ framework: Refuse, Reduce, Reuse, Repair, Refurbish, Re-manufacture, Repurpose, Recycle, and Recover. Each of these strategies represent a different level of retention of resource value, yet the upstream strategies (Refuse, Reduce, Reuse) are preferable to downstream strategies (Recycle, Recover) to maintain material value and consume less energy (Kirchherr et al., 2017) in the course of SWM.

Solid Waste Management (SWM) is associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in accordance with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations (Tchobanoglous et al., 1993). In the context of CE, SWM evolves from disposal efficiency to resource recovery, material valorization, and environmental protection. It also emphasizes climate change mitigation through reduced methane emissions from landfills and carbon emission in the cost of valuable resource loss in Waste to Energy (WtE) models. Therefore, CE is dependent on adopted SWM governance system.

In SWM, governance is the formal and informal processes, structures, rules, and arrangements through which collective decisions are made, implemented, and enforced in the SWM system (Rhodes, 1996). This encompasses policy formulation at national and local levels, regulatory frameworks, enforcement mechanisms, financial instruments (taxes, subsidies, Extended Producer Responsibility Schemes (EPRS), and Stakeholder Engagement Processes (SEP). Effective SWM governance creates an enabling environment for CE by aligning incentives, removing barriers, and ensuring accountability. In SWM governance from CE perspective, different theoretical models emphasize different aspects yet collectively emphasizes for material recovery from the solid waste.

Among others, new institutionalism (NI) model provides a process of understanding policy failures and governance challenges (North, 1990) that limits CE in SWM. The individual choices and organizational behaviors are deeply constrained by institutions the formal rules (policies, laws, regulations) and informal norms (cultural practices, social expectations) that structure social interactions. Hence, new institutionalism explains Policy Failure as the process and mechanism of path dependency and institutional lock-in such as initial large investment decisions, including contractual obligations, and political constituencies making it difficult to reverse or adopt complementary or alternative systems such as CE, rather force to continue

initial choices (Stead, 2014). Recognizing and incorporating stakeholders in SWM policies can have positive feedback for CE.

The Stakeholder Theory in SWM governance focuses on social dimensions of CE, particularly regarding the role of marginalized actors (Freeman, 1984) such as informal waste collector. As the theory believes that the success of any organization or system depends on managing relationships with all groups that can affect or are affected by its activities, effective governance cannot be achieved through top-down mandates, including in SWM system, but requires the integration of legitimate interests and contributions of all stakeholders, including those traditionally excluded from formal decision-making processes (Ramaswami et al., 2022). The informal waste-actors possess valuable knowledge, have established collection networks, and proven sorting capabilities, excluding them from partnership by any SWM system affects material recovery rates, particularly in resource-constrained settings such as in global south (Wilson et al., 2006). Therefore, transforming them from marginalized informal workers into recognized stakeholders of SWM, with formal roles and protections, becomes both an ethical imperative and an operational necessity (Pandey, 2004) for successful CE. However, without systematic thinking, recognition of stakeholders and corresponding effects is challenging.

Systems Thinking (ST) is a conceptualization of SWM as a complex adaptive system characterized by feedback loops. It believes that interventions at one point in the system (e.g., improving collection efficiency) can have counter-intuitive effects elsewhere (e.g., overwhelming processing capacity) or produce delayed responses that are not immediately apparent (e.g., behavioral changes following awareness campaigns may take years to materialize). Therefore, time delays, non-linearity in relationships, and emergent properties are common to Systemic Thinking (Sterman, 2020) so its application is essential for designing rational policies and practice of CE in SWM. Systemic thinking leads to life cycle thinking - a methodological framework that demands for an assessment of social, environmental, and economic impacts of products life - input to output, use and disposal, such as CE in SWM, in present context (ISO 14040, 2006). The life cycle thinking is manifested through life cycle approach methodologies that compare different waste treatment pathways by accounting for all inputs (energy, water, chemicals) and outputs (emissions, residues, recovered materials) across the full process chain (Kovács et al., 2023). The life cycle assessment is crucial for comparing the environmental performance of different waste treatment scenarios (e.g., landfilling vs. composting vs. Incineration vs. CE) and identifies potential shifting logically so solving one environmental problem shall not create another (Kang et al., 2023) to ensure sustainability.

Integrated Sustainability Assessment (ISA) is a holistic evaluation framework that measures and weighs the environmental, economic, and social performance of a system or policy intervention (Hupples & Ishikawa, 2005). It comprises three interconnected assessments: Environmental Life Cycle Assessment (E-LCA), Life Cycle Costing (LCC) that analyzes economic impacts across the life cycle, and Social Life Cycle Assessment (S-LCA) that evaluates impacts on human well-being, labor conditions, and equity. The ISA represents the evolution of sustainability assessment to match the multidimensional nature of CE goals (Ceraso & Cesaro, 2024) that meant to create a Zero-waste City.

The goal of the conceptual and theoretical components of CE is to create a Zero-waste City (ZWC). It is a comprehensive, macro-level governance and policy model designed to implement CE principles across an entire urban jurisdiction (Qi et al., 2024). The ZWC concept implies a systemic approach aiming for near-zero land-filling by maximizing resource efficiency at all stages, promoting industrial symbiosis and material exchange networks, enforcing strict source separation requirements, and fundamentally transforming production and consumption patterns. The model requires significant cross-sectoral coordination and integrated planning across municipal, industrial, and community scales (Huang et al., 2025). However, the goal of ZWC is often affected by a Path Dependency of SWM governance that historical decisions constrain current and future choices, even when those original decisions may no longer be optimal (North, 1990) but cannot be ignored or discarded. In CE-SWM contexts, path dependency manifests when large capital investments in linear infrastructure (e.g., incinerators, landfills)

create economic and political momentum that resists transition to CE alternatives. The sunk costs and ongoing financial commitments create powerful incentives to maintain throughput rather than reduce waste generation (Unruh, 2000).

The theoretical discussion above shows underlying possibilities and corresponding complexities. These possibilities and complexities are well documented by research works.

2.2 Empirical Evidence

The implementation of SWM–CE strategies is shaped by specific geographical, economic, and social contexts, particularly the Global North–South divide, which arises from differences in SWM governance, infrastructure, per capita consumption rates, regulatory frameworks, and optimization challenges. For example, Jensen and Olsen (2023) documented failure of CE due to new institutionalism, particularly in the countries of the North (Scandinavia) who prioritizes high incineration rates despite their ambitious CE policies. There are notable differences between the North and South in SWM systems regarding path dependency (locked-in waste-to-energy infrastructure versus formalization or centralization of SWM systems), consumer behavior change, and complex trade-offs between competing environmental goals. Examples include energy recovery versus material recycling, changing waste composition and separation at the point of origin, and informal sorting for livelihoods (Malinauskaite et al., 2017; Longfor et al., 2023). As a result, success indicators of CE differ accordingly.

Similarly, mediating assessment of success or failure involves connecting inputs to outcomes through the development and application of Integrated Sustainability Assessment (ISA) frameworks. The ISA provides decision-makers with comprehensive, multi-dimensional performance data (Ceraso & Cesaro, 2024). Such assessment is conducted using the three pillars of sustainability: environmental, social, and economic. Environmental assessment (E-LCA) quantifies impacts on climate (GHG emissions), resource depletion, pollution (air, water, and soil), and ecosystem health across the full life cycle of materials and processes (Kovács et al., 2023; Rotthong et al., 2025). Economic assessment (LCC) evaluates full life-cycle costs, including capital investment, operational expenses, externality costs, and the value of recovered materials, enabling accurate cost–benefit comparisons between linear and circular alternatives (Zhang et al., 2024). Social assessment (S-LCA) measures equity and justice dimensions such as employment quantity and quality, health and safety, equity and inclusion, community well-being, and distributional justice (Pandey et al., 2025). The literature indicates that this dimension remains the most underdeveloped in practice, despite its importance for political feasibility and long-term sustainability (Ceraso & Cesaro, 2024; Pandey, 2008).

The ultimate outcome of CE governance is effective and equitable CE implementation in SWM. Effectiveness and equity are measured through multiple indicators. These include material circularity, such as recycling rates, material recovery efficiency, secondary material market penetration, landfill diversion rates, and trends in waste generation per capita (D'Adamo et al., 2024). Environmental performance is assessed through GHG emission reductions, resource consumption savings, pollution prevention, and ecosystem health improvements (Jawjit et al., 2025; Longfor et al., 2023). Economic viability is evaluated based on cost-effectiveness, market value creation from waste streams, employment generation, and fiscal sustainability for municipalities (Zhang et al., 2024). Social equity is reflected through inclusive stakeholder participation, improved livelihoods for waste workers, community health benefits, and just distribution of costs and benefits (Wilson et al., 2015). This evidence indicates CE is not a straight forward solution to SWM governance. Nevertheless, it is just a quick generalization, and detailed study is conducted in this paper.

2.3 Research Gap

Since this is a systematic review-based paper, it intended to identify and document the knowledge in the SWM governance from CE perspective and find the research gaps. Therefore, its results are to pave the road

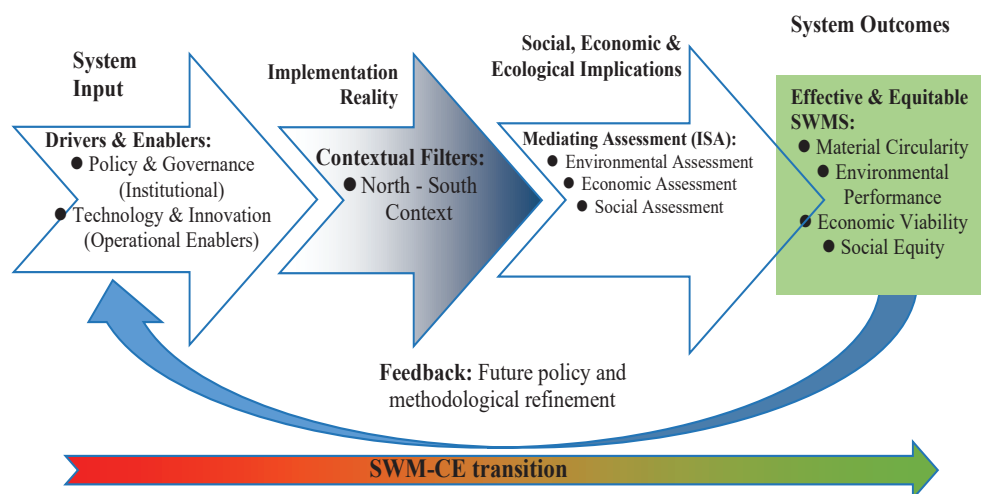
to further research in the field. This means that this research does not bridge the research gap it identified, rather consolidates scholarly works in a single paper and provides critical knowledge on the field, shows gaps to search empirical evidence before policy intervention in SWM governance, if the CE is prizable strategy? This paper shows strengths and limitations of CE under different circumstances and provides strategies to overcome such limitations, using innovative methodologies, committed stakeholders, and harmonizing society, environment, and economy. To meet this goal of knowledge creation, this research uses following conceptual framework.

2.4 Conceptual Framework

To direct this study within the scope of the paper, following conceptual framework was developed and applied. The framework illustrates that effective CE implementation is influenced by structural barriers of policy - practice gap and methodological fragmentation of CE and ISA (Figure 1).

Figure 1

Conceptual framework of Circular Economy in Solid Waste Management



Source: Designed by Author(s), based on literature review

As presented in the framework, the system inputs of the transition to CE are the drivers and enablers. Policy and governance are the institutional drivers that include national and local policies, economic instruments (taxes, subsidies, Extended Producer Responsibility schemes), enforcement mechanisms, and institutional coordination structures (D'Adamo et al., 2024). These drivers provide high-level mandate for CE and waste management strategies at the national level and zero-waste commitments for local governments. Such mandates offer strategic direction and economic incentives necessary for the transition to CE. To function this system effectively, it is necessary to limit path dependency and vested interests prevailing in linear SWM systems (North, 1990). Technology and innovation are operational or practical enablers that serve dual functions: optimizing existing operations to improve efficiency and enabling entirely new circular business models such as product-as-a-service and industrial symbiosis networks.

This framework incorporates a feedback loop in which outcomes inform future policy and methodological refinement (Sterman, 2020). When outcomes do not meet expectations, both policies and methodologies are refined to achieve the desired results. The conceptual framework also provides the structure for the thematic analysis in this paper, ensuring that findings are analysed in relation to their position within the broader systemic model. Each identified theme maps onto specific components of the framework, and the discussion examines relationships and dependencies among these components. This framework is further supported by the following methodology.

3. Materials and Methods

3.1 Search Strategy

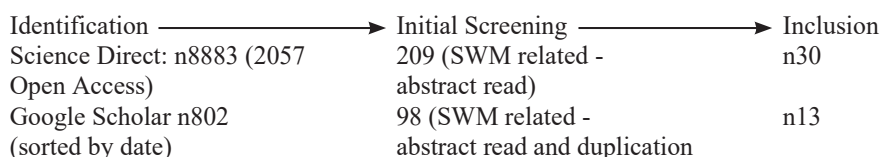
This research employs a Systematic Literature Review (SLR) approach to comprehend the findings from literature on the governance and methodological frameworks of CE in SWM and published between 2015 to 2025. The foundational data for this thematic analysis comprised 43 peer-reviewed open access journal articles (30 from Science Direct, 10 from Scimago indexed but not in Science Direct; and 3 from DOAJ indexed and not in Scimago or in Science Direct). The initial search on solid waste management appeared 8883 articles in science direct, with 2057 being open access. Among them 209 articles have been identified focusing on solid waste management. After reading the titles and abstract of those 209, 43 articles are found to have some components on circular economy of solid waste management, which are included in this review. These articles have been sourced from science direct (30), and google scholar (13), the process of Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) is demonstrated in Figure 2.

Figure 2

Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Flow

Search Strategy:

Key Words: Solid Waste Management Date: 17/10/2025 Location: Kathmandu



Although this research entertained only open access literature, it adequately covered the thematic areas of the research subject. There is richness of codes. As qualitative research concerns varieties of information rather than frequency and the literature covered both north-south and east-west geographically, therefore there is richness of data, demonstrated by developed codes, code groups, sub-themes and themes. We believe that unless research performs quantitative analysis in systematic review, richness rather than frequency is important. Therefore, the open access literature is adequate. Depending upon open access literature is also due to the financial reason since the institution in which the researchers are affiliated does not have subscription and the researchers cannot pay for it, neither personally nor through research project since research project is a small in terms of financial resource.

3.2 Data extraction, coding, and analysis

Initially, to familiarize with each article, a thorough reading of the abstract of each article was performed and initial notes were taken on the core themes, methodologies, findings, and contexts. Based on these patterns, the papers were grouped according to key CE–SWM policy and methodology, research methodology (quantitative, qualitative, review), and geographic area. Afterwards, open coding of the data and information, particularly the key findings extracted from each article (Ritchie & Spencer, 1994), was performed using the Atlas.ti 9 computer-assisted software. Open codes were generated inductively from the data itself, ensuring that the analysis remained grounded in empirical findings rather than imposed through preconceived categories. A total of 54 codes were initially developed, each code containing a specific meaning or definition. These codes were recategorized into 18 code groups and six themes. The analysis therefore focuses on these 18 sub-themes (code groups), and six themes, with consideration of specific codes where necessary. This hierarchical coding structure enables analysis at multiple levels of granularity, from specific practices and tools to systemic governance and methodological challenges of the circular economy. All analytical steps are documented and traceable, and the generated thematic networks and coding tables ensure internal consistency and synthesis (Gough et al., 2017), thereby assuring the quality of qualitative thematic research.

4. Analysis and Synthesis of Findings

This section presents the analysis of the developed coding framework to produce a thematic synthesis. The information is organized into tables to methodically structure the most pertinent information and the conclusions derived from each article. A total of 6 themes, 18 sub-themes and 54 codes have been developed to explore the knowledge and practice on circular economy of waste management.

4.1 Governance and Policy

Table 1 presents sub themes (3) and codes (8), and corresponding definitions and literature (11) focusing on governance and policies in the circular economy. Governance structures and policy instruments determine the pace of acceptance and acceleration of the CE framework. The literature highlights the requirement for robust policy frameworks that align with broader societal goals for effective CE implementation, which subsequently contribute to SDG attainment (Ajwani-Ramchandani & Bhattacharya, 2022), contextualizing national policies within a broader international framework. At the regional level, such as the EU sustainability framework, where waste efficiency is benchmarked as a key policy success metric, CE has been directly promoted (D'Adamo et al., 2024).

From the perspective of CE governance, CE policies are required to integrate all concerned stakeholders in compliance with international mandates. Formalizing and integrating waste pickers or scavengers is not only an equity issue but also a strategic necessity for achieving high recycling rates in cities of the Global South, such as Accra (Oteng-Ababio & Fobil, 2018) and Kathmandu (Pandey, 2004; 2008). Nevertheless, inclusion of the informal sector is not straightforward. Persistent policy–practice gaps indicate failures in national CE policies. Several barriers exist at local governance levels regarding the implementation of CE policies. Systemic challenges arising from weak local institutions and socio-economic contexts result in high incineration-rate lock-in (Malinauskaite et al., 2017) on the one hand, and high rates of landfilling, such as in Kathmandu and Accra, on the other.

Key findings from policy analysis highlight that failures and barriers outweigh successes. The persistence of high incineration rates in some developed systems, particularly in the EU, is identified as a potential policy failure due to long-term dependency on Waste-to-Energy (WtE) facilities, undermining efforts to enhance the 5Rs, particularly material recovery and recycling (Malinauskaite et al., 2017). Conversely, some policy studies emphasize positive non-formal outcomes, such as zero-waste lifestyles, recognizing that individual behavioral change, supported by societal awareness, is a crucial component of policy success (Zulkifli & Abd Manaf, 2024). As sound CE governance involves setting a clear strategic direction, such as a low-carbon transition framework (Rotthong et al., 2025), governance systems that remain flexible, adapt to local realities, and integrate diverse social and economic factors are more likely to produce effective outcomes.

Table 1

Theme 1 - Governance and Policies in Circular Economy

Sub-themes	Code	Code Definition	Relevant Articles (Author, Year)
Governance Policy and Practice	Waste Management and SDGs	Waste management practices are directly linked to global challenges and many of the UN - SDGs 2030. CE is helping to attain multiple UN - SDGs.	Velis & Vrancken (2020); Ajwani-Ramchandani & Bhattacharya (2022)
	Policy Analysis	Comprehensive analysis or review of regulations and policies related to waste management or CE (e.g., EU Green Deal).	Pamukçu et al. (2023)
		Municipal waste management efficiency as a key policy mechanism for driving overall EU sustainability targets.	D'Adamo et al. (2024)
	Zero Waste Lifestyle Practice	Individuals acquire knowledge and change behavior towards the Zero Waste (ZW) lifestyle, often outside of formal education.	Zulkifli & Abd Manaf (2024)

Sub-themes	Code	Code Definition	Relevant Articles (Author, Year)
Inclusion and Equity	Public / private /social stakeholders	Requirement for integrated efforts and collaboration from multiple public, private, and social stakeholders for successful CE governance.	Durgekar (2016)
	Waste Pickers	Involving waste pickers in the CE and transitioning to formalization and inclusivity.	Ajwani-Ramchandani & Bhattacharya (2022), Toboso-Chavero et al., (2025)
	Informal Sector in Recycling	There is a need to formalize and integrate the informal waste sector (waste pickers, and resource-recovery business) for CE success in developing cities.	Oteng-Ababio & Fobil (2018);
Governance Policy and Challenges	Regulatory Barriers	Identification of barriers hindering the application of CE such as a critical gap between national and local regulations	Mattson et al., (2024), Durgekar (2016)
	Policy Failure (High Incineration Rate)	Critique of waste management policy that leads to high incineration rates, potentially locking systems into WtE over material recovery.	Malinauskaite et al. (2017)

Source: Developed through Open Coding of Literature Selected for Systematic Review

4.2 Research Focus and Methods on Circular Economy

This theme includes three sub-themes, 13 codes, and corresponding definitions from 17 scientific works (Table 2), highlighting the intellectual depth and analytical tools adopted in the management of circular economy (CE) systems. As shown in Table 2, Life Cycle Assessment (LCA) is one of the most widely adopted tools to quantify the environmental and economic performance of various MSW management strategies, applied in contexts such as in Kinshasa, and in evaluating Waste-to-Energy (WtE) scenarios in Hungary (Kang et al., 2023; Kovács et al., 2023). The literature also calls for Integrated Sustainability Assessment (ISA) to address methodological gaps in incorporating social and economic dimensions of CE and material recovery alongside environmental assessment (Ceraso & Cesaro, 2024).

This review strengthens the methodological theme by consolidating benchmarks and identifying limitations of traditional tools. LCA studies (Kang et al., 2023; Kovács et al., 2023) emphasize the inclusion of a comparative LCA baseline (Finnveden et al., 2009) as a stable reference for assessing waste system impacts. Furthermore, gaps identified in the initial analysis are addressed by Manfredi and Vignali (2024), who provide a comprehensive review of Life Cycle Sustainability Assessment (LCSA) and highlight the need to shift from single-focus environmental LCA toward decision-making frameworks that integrate social and economic components. Complementing these approaches, Klemeš et al. (2021) demonstrate the applicability of System Dynamics Modeling for sustainability assessment in complex environmental and institutional settings, supporting the use of non-linear, systemic tools in CE-based waste management. The application of these tools reinforces integrated, multi-criteria evaluation practices in CE.

Several studies emphasize the importance of advanced modeling to capture the dynamic nature of waste flows and policy impacts. Ibarra Vega and Bautista-Rodriguez (2024) apply System Dynamics Modeling to assess long-term, non-linear effects of CE strategies, while D'Adamo et al. (2024) employ Data Envelopment Analysis (DEA) to benchmark performance and operational efficiency. Models such as MSW supply chain modeling apply techniques including the Ant Colony Algorithm to explore resource allocation and cost optimization (Pamukçu et al., 2023). Similarly, Campitelli et al. (2023) propose the Waste Management System Development Stage Concept (WMS-DSC) to assess waste management systems in the Global South. Collectively, these methods demonstrate that existing research provides quantifiable, multi-criteria evidence to support CE decision-making.

Table 2

Theme 2 - Research Focus and Methods on Circular Economy

Code Group	Code	Code Definition	Relevant Articles (Author, Year)
Assessment Modeling and Frameworks	System Dynamics Modeling	Use of Systems Dynamics methodology for developing models to study complex waste management trends and policy impacts.	Ibarra Vega & Bautista-Rodriguez (2024)
	Modified RIAM Assessment	Use of a Modified Rapid Impact Assessment Matrix (RIAM) method for assessing the environmental impact of MSW management scenarios.	Ghanbarzadeh Lak et al. (2025), Harfadli et al. (2025)
	6Rs Methodology	Novel "Refuse, Reduce, Reuse, Repair, Recycle, and Recover" (6R) methodology used for assessment.	Jawjit et al. (2025)
	MSW Supply Chain Modeling	Formulation of a mathematical model (e.g., MILP) for the MSW supply chain under uncertainty (e.g., Ant Colony Algorithm).	Pamukçu et al. (2023)
	System Dynamics for Complexity	Supports and details the use of System Dynamics in modeling complex sustainability issues.	Klemeš et al. (2021)
Assessment tools	WMS Development Stage Concept (WMS-DSC)	Novel holistic approach with five universal stages for assessing Waste Management Systems (WMSs) in the Global South.	Campitelli et al. (2023)
	Life Cycle Assessment (LCA)	Use of LCA to evaluate environmental impacts (GHG, water, energy) of construction or waste management scenarios.	Kang et al. (2023), Kovács et al. (2023), Matagi et al. (2024)
	Data Envelopment Analysis (DEA)	Use of DEA to assess efficiency in municipal waste management across countries or municipalities.	D'Adamo et al. (2024)
	Life Cycle Cost Model (LCC)	Development and application of a new LCC model for assessing CE value retention processes.	Zhang et ui. (2024)
	Metrics/ Indicators for CE	Importance of formulating and adopting meaningful CE indicators for performance measurement.	Zhou et al. (2022)

Code Group	Code	Code Definition	Relevant Articles (Author, Year)
Assessment scope and Gap	Multi-sectoral Integration	Research that combines waste management, energy recovery, and economic modeling.	Mazzoli et al. (2024), Rotthong et al. (2025)
	Integrated Sustainability Assessment (ISA)	Review of methodological tools for ISAs of urban waste management systems, noting lack of concurrent evaluation of social, environmental, and economic aspects.	Toboso-Chavero et al., (2025)
	LCSA Review and Future Perspectives	A comprehensive, recent review of Life Cycle Sustainability Assessment (LCSA) methodology.	Manfredi & Vignali (2024)

Source: Developed through Open Coding of Literature Selected for Systematic Review

4.3 Strategy and Implementation of Circular Economy

This theme consists of four sub-themes and 16 codes derived from 16 scientific publications (Table 3). It analyses the practical actions and strategies employed to advance the circular economy (CE) of waste management. The literature frames that advanced technology, driven by economic necessity, is transitioning waste management toward the circular economy. The code I4.0 Technology for CE–SDG highlights the crucial role of digital tools, such as Industry 4.0 applications, in optimizing resource tracking and management to simultaneously achieve CE objectives and the Sustainable Development Goals (SDGs) (Ajwani-Ramchandani & Bhattacharya, 2022). This digital transformation enhances material circularity and use efficiency, fostering optimal performance of municipal waste management systems (D’Adamo et al., 2024).

There is a evidence beyond the identification of CE technologies that assesses the economic viability of CE. CE concepts reviewed by Ghisellini et al. (2016) shed light on challenges and perspectives in both theoretical understanding and practical strategies, such as Waste-to-Chemicals (Mishra et al., 2023) and Waste-to-Energy (Kovács et al., 2023). Ribeiro and Santos (2021) further provide a sustainability assessment of WtE, emphasizing energy recovery against environmental costs.

The theme is broadened by strategies such as zero waste (ZW) in urban environments and low-tech resource recovery and composting approaches (Bhattarai et al., 2019). The literature also emphasizes hierarchical waste treatment strategies, such as the 3Rs and 5Rs, noting successful commercial and non-commercial models in countries such as Denmark and Sweden (Moalem & Schmidt, 2023), despite structural challenges in the Global South. While Waste-to-Energy (WtE) technologies remain a pragmatic option in Europe (Malinauskaite et al., 2017; Kovács et al., 2023), emphasis is increasingly shifting toward higher-value recovery pathways, such as Waste-to-Chemicals (WtC) and the transformation of waste into valuable feedstocks (Mishra et al., 2023). In these contexts, both high-tech digitization (Industry 4.0) and optimized low-tech municipal resource recovery and composting strategies are adopted.

Nevertheless, the practicality of these systems remains questioned, as the literature also assesses Life Cycle Costing (LCC) as a multifaceted strategic approach emphasizing smart systems, resource longevity, and economic accountability for long-term viability, including kerbside material looping (Zhang et al., 2024).

Table 3

Theme 3 - Strategies and Implementation of Circular Economy

Sub-Themes	Code	Code Definition	Relevant Articles (Author, Year)
Technology and Energy	I4.0 Technology for CE-SDG	Discussion on the application of advanced technology (like Industry 4.0) as an enabler of circular economy contributing to a number of SDGs.	Ajwani-Ramchandani & Bhattacharya (2022)
	Low-Carbon Transition Framework	Application of a low-carbon transition framework to combine waste-to-energy and use of waste as a source of renewable energy or proposal to shift high-carbon systems of WtE to low carbon system such as	Rotthong et al. (2025)
	Waste-to-Energy (WtE) Technologies	Introduction of integrated WtE model and technologies such as incineration and biogas for energy recovery from waste.	Kovács et al. (2023), Malinauskaite et al. (2017)
	WtE Sustainability Assessment	Sustainability assessment of WtE technologies balancing material vs. energy recovery.	Ribeiro & Santos (2021)
	Waste-to-Chemicals (WtC)	Green solutions and technologies as an option for converting waste streams into valuable chemical feedstocks or products for the bio-economy.	Mishra et al. (2023)
Circular Economy Programs	Extended Producer Responsibility (EPR)	Proposal for an Extended Producer's Responsibility Protocol (a policy framework) for Circular Economy.	Ajwani-Ramchandani & Bhattacharya (2022)
	Conceptual Clarity on CE	Discussion on foundational concepts on CE, CE definitions, and exploration of broad implementation challenges in CE.	Ghisellini et al. (2016)
	Economic Incentives	Evaluation of economic incentives as a strategy to promote circular economy adoption.	Ibarra Vega & Bautista-Rodriguez, (2024).
Waste Stream Management	CE in Manufacturing Industries	Review of CE implementation in industrial and manufacturing sectors.	Lieder & Rashid (2017)
	Composting vs. Landfilling	Compares the environmental benefits of composting organic waste versus traditional landfilling in a developing country, with a case study from Nepal.	Bhattarai et al. (2019)
	Kerbside (household waste separated and placed into specific containers of local authorities)	Assessment of Life Cycle Costs (LCC) for different kerbside waste separation and material looping processes.	Zhang et al., (2024)
	Material Looping Cost (LCC)		

Sub-Themes	Code	Code Definition	Relevant Articles (Author, Year)
	Optimizing Recycling and Reusing Capacity	Evaluated the strategies of waste sorting, recycling, and reusing in relation to infrastructure and systemic change.	van Hees et al. (2025)
5Rs (Reduce, Reuse, Repair, Refurbish, Recycle)	Closed-loop vs. Open-loop Recycling	Comparative analysis of cost performance between closed-loop (materials re-entering the original product stream) and open-loop (down-cycling) recycling methods.	Zhang et al., (2024)
	Repair and Reuse Systems	Analysis of systems that support product lifespan extension through commercial and non-commercial repair and reuse activities.	Moalem & Schmidt (2023)
	Circular Material Use/ Efficiency	Focus on optimizing rates of recycling, circular material use, and assessing municipal waste efficiency.	D'Adamo et al. (2024), Zhou et al. (2022)

Source: Developed through Open Coding of Literature Selected for Systematic Review

4.4 Context and Case Studies on Circular Economy

This theme consists of three sub-themes, five codes, and corresponding definitions identified from 13 scientific publications (Table 4). Empirical observations demonstrate the versatility and context-dependence of CE applications. Research on CE is predominantly concentrated on urban or city-scale applications in the Global South (Matagi et al., 2024; Harfadli et al., 2025), reflecting the widespread waste management challenges faced by cities such as Marrakech, Balikpapan, Kinshasa, Kathmandu, and Fiji (Campitelli et al., 2023; Kang et al., 2023; Matagi et al., 2024; Pandey, 2008). This geographical focus is critical for developing context-specific solutions, particularly for regions such as Sub-Saharan Africa (Longfor et al., 2023) and South Asia. This is further supported by comprehensive reviews of regional challenges (Wilson et al., 2015), providing a richer context for interpretation.

A growing sectoral focus is observed in the transition toward Zero-Waste Cities and Industrial Parks in China, which represents not merely a municipal initiative but also a complex application of CE within large-scale industrial ecosystems, addressing substantial volumes of industrial solid waste (Qi et al., 2024; Huang et al., 2025; Wu et al., 2025). These cases, together with reviews by Lieder and Rashid (2017), identify the strategic role of industrial CE implementation in the manufacturing sector. This highlights the Chinese model as an emerging regional archetype for industrial solid waste management across East, Southeast, and South Asia. Urban mining in developing countries and the role of the informal sector (Oteng-Ababio & Fobil, 2018) further provide critical insights into material flows within informal systems, which are vital for CE in cities of the Global South.

However, CE applications are not limited to the Global South. In developed contexts, particularly in European countries, studies typically focus on benchmarking efficiency and evaluating specific Waste-to-Energy (WtE) technologies within existing systems (D'Adamo et al., 2024; Kovács et al., 2023). The concept of zero waste in informal housing also demonstrates the potential of CE principles to enhance resource security and living standards among the urban poor (Elgizawy et al., 2016; Pandey, 2008).

Table 4

Theme 4 - Context and Case Studies on Circular Economy

Code Group	Code	Code Definition	Relevant Articles (Author, Year)
Context/ Geography (Developing Economy Focus)	Urban/ City-scale Application (Global South)	Case studies or models applied specifically to metropolitan cities in developing/emerging economies.	Campitelli et al. (2023), Kang et al. (2023), Longfor et al. (2023), Matagi et al. (2024), Harfadli et al. (2025)
Context/ Geography (Developed Economy Focus)	European Context (EU)	Studies focusing on waste management efficiency or WtE in the European Union (EU) / European countries (e.g., Hungary, Sweden, Denmark).	D'Adamo et al. (2024), Kovács et al. (2023), Malinauskaite et al. (2017)
Context/ Geography (Sector Specific)	Informal Housing (Slum)	Focus on applying CE and Zero Waste (ZW) strategies in the context of informal and self-built housing developments by / for urban poor.	Elgizawy et al. (2016)
	Zero-Waste City /Park	Case studies and practical implementation paths for the "Zero-Waste City" concept in a regional (China) and in industrial/chemical park setting.	Qi et al. (2024), Huang et al. (2025), Wu et al. (2025)

Source: Developed through Open Coding of Literature Selected for Systematic Review

4.5 Environmental Impacts and Benefits of Circular Economy

The environmental efficacy of CE strategies is assessed through a systematic review of nine studies, grouped into three sub-themes, five codes, and respective definitions (Table 5). The primary focus of this theme is on climate change and resource conservation, yet limited number of literature and corresponding sub-themes and codes indicate that environmental impacts and benefits of CE are relatively less investigated issues. The most frequently quantified benefit of CE is reduction of GHG emissions, as highlighted by Sleede and Kaza (2023), providing a holistic perspective on reducing emissions from solid waste, while emphasizing localized mitigation efforts. Studies from Sub-Saharan Africa and Asia demonstrate substantial potential for mitigating GHG emissions through sustainable waste management and optimized CE models (Longfor et al., 2023; Jawjit et al., 2025), including bottom-up calculations of emissions associated with organic waste management systems (Madden et al., 2023). Accurate climate accounting relies on biomass accounting, addressing the complexities of biogenic content in combusted waste and associated CO₂ emissions (Moora et al., 2017).

This theme also engages with the environmental trade-offs between composting and landfilling in municipal decision-making. Bhattarai et al. (2019) provide data on these trade-offs, a major source of methane emissions, highlighting key areas for climate action. This practical mitigation complements strategic, forward-looking approaches, such as Climate Resilience and Nature-based Solutions (NbS) modeling, which aim to create resilient urban environments. The synergy of waste management with energy policy is captured under renewable energy generation, confirming the role of Waste-to-Energy (WtE) in producing heat and electricity (Kovács et al., 2023). Mazzoli et al. (2024) and Rotthong et al. (2025) present comprehensive environmental assessments using a multi-sectoral integration approach, holistically evaluating waste alternatives toward carbon neutrality and environmental sustainability in large urban systems, such as India. Overall, the literature demonstrates the contribution of the waste sector to broader urban adaptation efforts through GHG emission reduction from municipal waste.

Table 5

Theme 5 - Environmental Impacts and Benefits of Circular Economy

Code Group	Code	Code Definition	Relevant Articles (Author, Year)
Climate Change Mitigation	GHG/Emissions Reduction	Quantification of potential carbon/GHG emission reductions through CE strategies, LCA scenario comparisons, and WMS optimization. Provides a global overview and policy options for reducing GHG emissions from the waste sector.	Jawjit et al. (2025), Longfor et al. (2023), Madden et al. (2023) Sleede & Kaza (2023)
	Biomass CO2 Accounting	Determination and proper accounting of the biomass content in combusted municipal waste and associated CO2 emissions.	Moora et al. (2017)
	Climate Resilience and Nature Based Solution (NbS) Modeling	Modelling the intersection of the MSW with climate resilience and adaptation, using Nature-based Solutions (NbS).	Iqbal et al. (2024)
Resource Recovery	Renewable Energy Generation	Potential for generating substantial renewable energy (e.g., heat, biogas) from waste streams.	Kovács et al. (2023)
Waste Diversion	Landfill Life Estimation/Minimization	Mathematical estimation of useful life of sanitary landfills and strategies towards minimizing reliance on landfilling.	Ibarra Vega & Bautista-Rodriguez (2024), Saif et al., (2017)

Source: Developed through Open Coding of Literature Selected for Systematic Review

4.6 Challenges and Barriers to Circular Economy

As presented in Table 6, the literature enriches this theme, particularly in the critical assessment of obstacles preventing the full realization of CE. The analysis highlights systemic issues, infrastructural deficits, and institutional weaknesses in developing countries. A major focus is on the challenges faced by low- and middle-income countries (LMICs), such as budget constraints, inadequate technical infrastructure, and uncontrolled disposal, making CE transitions more complex than in developed economies (Longfor et al., 2023; Campitelli et al., 2023). For CE models to succeed, infrastructure, multi-stakeholder collaboration, and strategic government support are essential (Durgekar, 2016).

Foundational data and frameworks are provided by the World Bank's What a Waste (Hoornweg & Bhada-Tata, 2012) and the systematic review by Wilson et al. (2015), validating the urgency of action as suggested by Campitelli et al. (2023) and Longfor et al. (2023). Other challenges include the policy–practice gap; lack of institutional capacity and weak regulatory enforcement prevent the transition to circularity, affecting high-order circular practices. Furthermore, there exist constraints on urban mining in developing countries limit high-value resource recovery despite available materials.

The literature also identifies operational barriers, such as those captured under the code Drivers and Barriers to Up-cycling in Table 6, which outlines logistical, regulatory, and economic hurdles faced by urban up-cycling initiatives, despite their importance for higher-order resource retention (van Hees et al., 2025). Systemic constraints also exist in the Global North, where high incineration rates create policy lock-ins in CE (Malinauskaite et al., 2017). Overall, financial limitations in the Global South and structural rigidity in established European waste management systems represent key barriers to the effective implementation of CE policies and practices.

Table 6
Theme 6 - Challenges and Barriers on Circular Economy

Code Group	Code	Code Definition	Relevant Articles (Author, Year)
Infrastructure & Capacity	Challenges in Developing Countries	Several challenges like inadequate waste management infrastructure, informal disposal, and low levels of reuse/recycling in low- and middle-income countries.	Campitelli et al. (2023), Longfor et al. (2023)
		Provided foundational data and a global review of MSW management challenges, particularly in the context of developing regions.	Hoornweg & Bhada-Tata (2012)
	Drivers and Barriers to Up-cycling Need for Infrastructure/ Collaboration	Detailed review of the structural and institutional challenges facing waste management in developing nations.	Wilson et al. (2015)
		Motives, drivers, and barriers (e.g., institutional, logistical) to implementing urban up-cycling initiatives.	van Hees et al. (2025)
Systemic Constraints	Waste Generation / Consumption Increase	Identification of needed improvements in infrastructure and collaboration for successful CE model operation.	Durgekar (2016)
		Contextual setting describes continuous increase in waste generation due to population growth and consumption trends.	Ibarra Vega & Bautista-Rodriguez, (2024).
	Lack of Transparency (Waste System) High Incineration Rate	Highlighting the issue of low transparency within the waste management system and politics in systemic operations	Durgekar (2016),
		Quantified high percentage of MSW being incinerated, often as a policy constraint against full CE in advanced economies.	Malinauskaite et al. (2017)

Source: Developed through Open Coding of Literature Selected for Systematic Review

5. Conclusions and Recommendations

The study aimed to review and analyze the literature on governing the solid waste management system through the perspective of circular economy, encompassing six major themes, i.e., Governance and Policy, Research Focus and Method, Strategies and Implementation, Context and Case Studies, Environmental Impact and Benefits, and Challenges and Barriers. The findings collectively demonstrate agreement on the significance of the circular economy in governing solid waste management system, particularly for harmonizing livelihoods of informal workers, environmental balance and developmental / economic outcomes. However, several inhibitors were also identified that constrain the practice of CE. As revealed by the findings, governance systems and policies that are inclusive and locally viable are among the determining factors in CE adoption and success. Conversely, inept and dysfunctional governance and policies can substantially undermine the transition to the circular economy in waste management. The literature highlights the stark reality that cases of CE failure often outweigh successes due to institutional and policy bottlenecks. Similarly, the urgency of applying integrated assessment models to analyze the impact of MSW management practices is emphasized, considering the deficiencies of linear models, such as the Life Cycle Assessment (LCA), which evaluate environmental issues entirely from a technical

perspective while ignoring socio-cultural, techno-economic, and politico-institutional realities. The adoption of CE is significantly eased by technological breakthroughs as well as the establishment of national and international frameworks, including the SDGs. Although CE adoption is critical across all regions of the world, irrespective of their economic structure and status, several challenges remain. Developed countries face structural lock-ins despite economic potential and sound infrastructure, while developing countries face scarcity of resources and limited government willingness to adopt CE models. To avoid the irreversible loss of finite planetary resources, the integration and operationalization of CE models in solid waste management system is the only alternative that reconciles development with environmental sustainability.

Study Limitation: Being qualitative research uses adequate literature to reach a valid conclusion. However, review is limited only to open access literature, which may have compromised some valuable information which the subscription only literature has noted. The quality of research depends on time and cost. Due to limited cost and not having institutional subscription of many scientific journals, we could not afford subscription journals so relied on open access. However, as the abstract of other subscription only literature was also thoroughly reviewed to check if new information (code) appeared, the developed codes were adequately saturated to the research subject. There was no bias in geographical location since both North-South and East-West were covered. However, we do not claim for lacking language-bias since only the literature published in the English Language are reviewed. There is an absence of gray literature since we prioritised scientific literature because of their authenticity in data and information.

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