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Review

Transition and Implementation of Circular Economy in Municipal Solid Waste Management System in Nigeria: A Systematic Review of the Literature

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Abstract: As the environment reaches field capacity and is unable to regenerate waste naturally, challenges resulting from municipal solid waste management (MSWM) are showing a global increase, especially in developing countries. Nigeria is a country with a huge quantity of municipal solid waste (MSW) without a functional and operational MSWM system. This systematic review of the literature (SLR) aimed at investigating knowledge application in view of the circular economy (CE) model in the management of MSW in Nigeria, while answering research questions on the adoption and implementation of the circularity principle. In line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, a comprehensive search strategy was developed to source electronic versions of updated articles from the Scopus, Web of Science, and Sage databases. The search retrieved 476, 878, and 374 results, respectively. The search was limited to publications written in the English language between 2008 and 2022 and was downloaded via Endnote and screened using Rayyan.ai. The SLR was conducted between February and October 2022. Findings revealed some potential opportunities for the transition and implementation of CE by identifying major indicators and enablers, but pointed out some barriers, including weak legislation, poor funding, the non-engagement of professionals, the absence of infrastructure, a lack of strategic planning, uncivilized behavioral conduct, and demography. The need to improve the current practice of MSWM from the linear economy (LE) of take–make–dispose is crucial. Summarily, the transition towards CE in MSWM is feasible and it can be initiated through the application of the 3Rs and 12Rs while anticipating the provision of infrastructural and novel technologies for a functional MSWM framework.

Keywords: circular economy; municipal solid waste management; Nigeria; sustainable; practice

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1. Introduction

Challenges resulting from the management of municipal solid waste (MSW) are on the rise globally due to MSW mismanagement, rural–urban migration, population growth, commercial, industrial, and socioeconomic activities, leading to increased volumes of MSW and unplanned or a lack of functional municipal solid waste management (MSWM) facilities, especially in developing countries [1]. From the 2.1 billion tons of annual MSW generated in 2016, 3.40 billion tons are predicted to be generated from 2050 [2]. Considering the above and taking climate change into consideration, effort is required on the part of city dwellers to develop MSW minimization strategies to shift away from the existing linear economy model of take–make–dispose that is currently practiced [3]. With the numerous advantages attributed to the adoption of a circular economy (CE), it is necessary to reform the practice of MSWM so that, amongst other benefits, a reduction in the volume of MSW disposed of in landfills can be achieved in line with the principles of CE [4]. CE focuses on the enhancement of environmental sustainability through the promotion of

waste reevaluation, a reduction in pollutants, a reduction in the excessive extraction of natural or raw materials, and the reutilization of waste [5].

This research is centered on MSW, which is regarded as waste generated and disposed of by residential city dwellers and small commercial business operators. MSW is said to be in a solid or semi-solid state, exclusive of wastewater and hazardous waste [6]. The management of MSW is multidisciplinary and multifaceted in its operation, spanning MSW generation, storage, collection, transfer, transportation, treatment, and disposal [7]; this is especially the case in today's world, where MSW is regarded as a resource to be utilized and is not completely regarded as trash to be discarded. Therefore, applying the CE model in MSWM is highly beneficial [8]. The aim of this research is to review the practices of MSWM in line with closing the loop for enhanced waste minimization for a sustainable environment and improved public health practices, with the objective of identifying the status of CE implementation in the MSWM system in Nigeria. In response to this, four research questions (RQs) are proposed to streamline relevant findings for the systematic review of the literature (SLR). The RQs are as follows.

RQ 1: From preceding studies on sustainable municipal solid waste management (MSWM), what are the indicators of circular economy (CE) implementation in the MSWM system in Nigeria?

RQ 2: From preceding studies on sustainable MSWM, what are the key enablers for the implementation of CE in the MSWM system in Nigeria?

RQ 3: From preceding studies on sustainable MSWM, what are the barriers impeding CE integration and implementation in the MSWM system in Nigeria?

RQ 4: From preceding studies on sustainable MSWM, what is the current practice of waste management in Nigeria?

1.1. Solid Waste Management in Nigeria

The Sub-Saharan African region is faced with enormous environmental challenges and Nigeria is not exempt from such challenges as they relate to MSWM in the context of this paper. In Nigeria, poor waste collection is eminent; however, 44% average collection is estimated for African nations [2], of which 80% of recyclable MSW components are accounted for as being discharged to dumpsites, while only 12% are recycled [9]. MSWM in Nigeria, as well as other developing nations, is characterized by a lack of waste generation data, an absence of waste sorting scheme(s), limited service coverage, inefficient operation, a limited percentage of recycling activities, and inadequate practices [10]. Although the current situation of MSWM in Nigeria is witnessing some level of improved landfill infrastructure and public–private partnerships (PPP), the continued rural–urban migration, the poor funding of the waste sector, the lack of infrastructure, and the absence of novel technologies are some drawbacks mitigating any potential advancement, thereby placing the MSWM system in a stagnant and poor state. This is likened to the past, where poor policy regimes, inadequate funding, and an absence of waste collection data negatively impacted the MSWM system [11,12]. In Nigeria, the government at all levels, especially at the provincial or state level, is responsible for MSWM [13].

However, as some countries with a similar demography of rapid urbanization [14], the failure of the government in legislation, weak policy implementation, a lack of political will, corruption, and the non-engagement of professionals are major factors leading to a slow transition to integrated sustainable MSWM as well as the poor behavioral conduct of the populace in properly handling generated waste at a household level [15–17]. In Nigeria, the current system or practice of MSWM is based on a linear economy (LE) approach, which comprises generating MSW, followed by storage, collection, transportation, and disposal at a dumpsite [18]. Figure 1 depicts this situation. In most cases, indiscriminate disposal of MSW by the roadside, in open pits, and in the drainage systems are prominent habits in a number of Nigerian municipalities. Meanwhile, in some rural areas, MSW is individually managed by each household in their backyards through the process of burning, burying, composting, or as animal feed, except on an occasional basis when provisions are

made by the government through waste contractors to collect, transport, and dispose of waste at dumpsites [19]. Promisingly, amidst the poor MSWM in most regions in Nigeria, the situation in Lagos State is changing as priority is now given to resource recovery through composting and the pelletization of plastics, nylons, and other non-biodegradable waste components. This has gradually paved the way for improved economic and social environmental sustainability. The resource conservation initiative in the state, resulting in the adoption of the Reduction, Reuse, Recovery, and Recycling (4Rs) principles in the MSWM system, is an indication of the potential opportunities to transform MSW into a 'valued' item through waste-to-wealth and renewable energy generation [20,21].

Figure 1. MSWM situation in some municipalities in Nigeria.

1.2. Conceptual Background

The conceptual background of this research is based on the CE model, which is solely divided into technical and biological categories, as presented in Figure 2. The technical aspect deals with materials that do not biodegrade, such as metals, glass, plastic, and polymers, but can be chemically or physically recycled. The biological aspect deals with materials that can undergo regeneration, such as materials that can be biologically redesigned into new useful products. In essence, CE is a model that opposes the LE practice [9] of take, make, and discard. Circularity encourages recycling, upcycling, remanufacturing, and repair, thereby discouraging the excessive extraction of raw materials, embracing sustainability, and limiting the volume of waste generated and disposed of in landfills [10,11]. The implementation of CE is a practical approach and the actualization of the United Nations' (UN) Sustainable Development Goals (SDGs), specifically SDGs 6, 7, 12, and 15, which focus on clean water and sanitation, clean but affordable energy, responsible consumption and manufacturing, and life on land, respectively [12]. Therefore, this research is a first step towards achieving the SDG focused on sanitation.

Some core elements of CE are Reduce, Recycle, and Reuse (3Rs); these elements have successfully promoted environmentally friendly cities in terms of cleanliness, by providing relevant solutions for waste reduction and upcycling. Moreover, waste segregation is another promising tool in the implementation of CE in developing countries [13,14]. The idea of decoupling economic growth from environmental degradation, while enhancing resource efficiency and waste minimization, is the foundation upon which CE is based. Although China, Japan, and Germany are pioneering countries in implementing CE, Denmark, Sweden, the Netherlands, and Scotland have also adopted the concept, while England, Austria, and Finland are still completing the integration of the concept [15]. CE is a veritable tool that has shown success in its application, with growing attention paid to sustainability in managing human activities and with opportunities to solve environmental challenges associated with MSW mismanagement. However, the concept has received little or no

attention in developing countries including Nigeria, even with the availability of resources such as huge volumes of various components of MSW [16–18]. CE is a multifaceted tool that promotes environmental sustainability, economic growth, and social inclusion through job provision while meeting various SDGs [19].

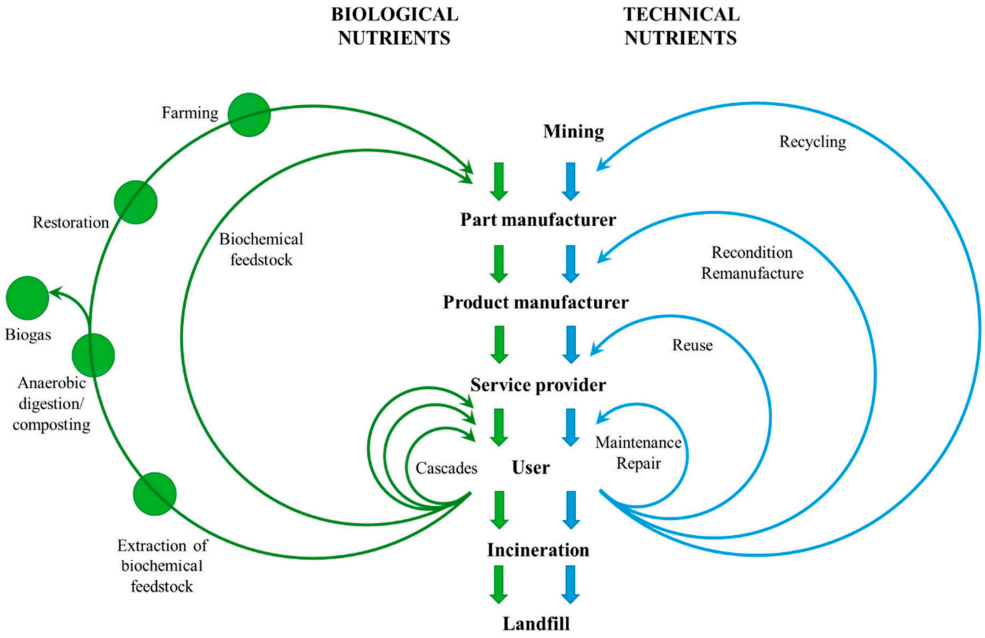

Figure 2. Circular economy diagram of biological and technical material cycle [22].

1.3. Circular Economy Indicators

The developmental analysis pointing to CE indicators is considered in this sub-section. In essence, CE indicators can be linked to three main categories, which are the environment, economy, and society. Sub-categories are a product of either or a combination of any of these three elements [23,24]. Some transitional approaches, through which CE can be implemented using MSWM systems, include harnessing the potential of both the public and private sectors [25,26]. Analyzing this further will require the development of a roadmap by adopting core indicators such as the environment, governance, economic operations, infrastructural projects, technological advancement, and job creation/social activities within a design period [27]. Further analysis of the activities impacting these core categories points to waste generation. Therefore, the development of a framework incorporating these factors can be implemented for CE in the management of MSW. This is because material flows, repair, reuse, recycling, reduction, waste utilization, waste-to-energy (W-t-E), composting, waste sorting at the source of generation, incineration, etc., are CE transitional enablers [27,28]. Moreover, the diversion of waste disposal from dumpsites to regeneration and reutilization, such as waste-to-wealth (W-t-W) and W-t-E initiatives, is an additional transitional indicator of CE [29,30].

1.4. Circular Economy Application in MSWM in Developed Nations

The application of the CE model has resulted in a reduction in the mining of raw materials and the sustainable management of extracted and used products in most developed countries [23]. CE has been proven not only to enhance the environment, but also to promote socioeconomic viability. Waste elimination in every facet, viewing MSW as a by-product through reutilization based on circularization through the principles of reduce, reuse, recycle, recovery, product life extension, product service, and a circular supply chain, as well as other approaches, represents the mainstream CE principle [31]. On the premise that CE enhances sustainable development, India is postulated to be able to unlock over half a trillion dollars of economic value by 2030 by adopting circularity principles [32]. The

practice in most emerging economies and developed nations has demonstrated the CE model as a veritable concept to achieve a more sustainable MSWM system [32–35].

Between 2000 and 2015, most Organization for Economic Co-Operation and Development (OECD) countries have achieved reductions in terms of MSW generation rates. The reduction, estimated at approximately 6%, is as a result of policy actions focusing on environmental performance reviews. Other environmentally sustainable, and CE concepts adopted include recycling and recovery, energy recovery through incineration, the abolishment of landfills, etc. Such practices have led to an average waste-to-energy rate of 20% for MSW, 55% recycling, and 35% composting in Japan, the Netherlands, Norway, and Estonia. Other aspects are financial investment in the waste sector, international co-operation using lean principles through learning from a functional system, policy enactment, the abolishment of dumpsite disposal, the implementation of extended producer responsibility (EPR), public campaigns and awareness, the participation of non-governmental bodies, the development of frameworks, and the provision of technological waste management infrastructural facilities [36,37].

The implementable variables of CE are maintenance and repair; separation technologies; digitalization—such as generating real-time data about the availability, location, and composition of MSW to boost efficient traceability and collection by service providers; urban planning [38]; service provider support for raw materials; the marketing of recovery-based products; refurbishment; the value measurement of commodities; logistics and supply chain management; and the recycling of waste products [39]. Because waste is generated from materials or products, beyond the 3Rs of reduce, reuse, and recycle, the 12Rs of circularization, which are refuse, reduce, reuse, repair, refurbish, renovate, return, recycle, recover, re-manufacture, redesign, and rethink, should be prioritized with the circular economy in mind [40]. China, Europe, and the United States of America have successfully implemented the 3Rs, which are drivers or processes of CE, with significant success achieved [38,41,42].

2. Methodology

The chronological description of the methodology adopted in this systematic review of the literature is presented in this section. The procedure followed is in accordance with the guidelines and checklist based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol (see Appendix A). PRISMA is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses [43]. The PRISMA protocol was used herein because it allows for a holistic literature search across multiple resources, with a clear sequence for adoption by the researcher. The PRISMA protocol complies with the research process of Source, Appearance, Method, Timeliness, Applicability, and Balance (SAMTAB), which guarantees an assessment of the literature's reliability and validity [44,45]; therefore, it is highly relevant for a systematic literature review such as this.

2.1. Protocol and Registration

With the insight that a well-developed protocol limits bias, defines a research roadmap, and leads to a problem-free systematic review of the literature, the researchers developed a comprehensive protocol that first checked to ensure that the title of the paper was not duplicated. To ensure the reliability of the review, the protocol developed followed the sequence of research question proposal, inclusion criteria, search strategy, study selection, quality and risk of bias consideration, data extraction, data analysis, and reporting.

2.2. Inclusion Criteria

The framework for the inclusion criteria was based on the Problem Intervention Comparison and Outcome (PICO) approach, as detailed below.

Problem: The focal problem of the review on which the eligibility or inclusion criteria were based was derived from published research on MSWM and trends in the implementation of CE in the MSWM systems in developing countries, with a focus on Nigeria.

Intervention: The included articles were streamlined to those providing an implementable roadmap for sustainable MSWM, effective MSWM, enablers for the transition, the implementation of CE in MSWM systems, and opportunities for the integration of CE in developing countries.

Comparison: Consideration was made for case-study-based research and peer-reviewed papers with a core focus on developing countries such as Nigeria, with a target of the successful implementation of CE in the management of MSW. Moreover, articles outlining barriers and drivers towards the recovery of MSW components and the current practice of MSWM were of prime interest for comparison.

Outcome: The inclusion criteria were limited to articles providing relevant solutions to the research questions. In addition, the inclusion criteria captured relevant articles that were published between 2008 and 2022, and the study design focused on articles published in English and within the fields of environmental science, energy, the social sciences, and civil engineering. Due to the demography of this research, peer-reviewed and conference papers were included. Literature published in the medical field, published abstracts, review notes, and textbooks were excluded.

2.3. Sources and Search Strategy

To obtain the relevant literature, a robust, comprehensive search strategy was developed to source electronic versions of updated articles in the Scopus, Web of Science, and Sage databases, with the search retrieving 476, 878, and 374 results, respectively. The keywords and search strategy used are presented in Table 1. The Boolean "AND" was used in adding each of the concepts in a new field.

Table 1. Keywords and search strategy.

Concept	Search Strategy
Municipal Solid Waste	"Municipal Solid Waste" OR "Solid Waste" OR Landfill OR MSW OR "Municipal Waste" OR "Waste Management" OR "Waste Flow" OR "Municipal Solid Waste Management" OR "MSWM" OR "Household Waste" OR "Municipal Solid Waste Handling" OR "Municipal Solid Waste Characterization" OR "Municipal Solid Waste Generation"
Circular Economy	"Circular Economy" OR Bioeconomy OR "Sustainable Economy" OR "Reusable Materials" OR "Sustainable Development Goals" OR SDGs OR "Recyclable Waste"
Nigeria	Nigeria * OR Africa * OR "Developing Country" OR "Developing Countries" OR "Low-Income Countries" OR "Low-Income Country" OR "Emerging Economy" OR "Developed Countries"

* is used to retrieve any word that begins or ends with a root or stem word during search.

2.4. Study Selection

The populated results obtained from the databases were exported to the Endnote citation manager and were also saved in a downloaded folder on the researchers' computer and subsequently exported to the rayyan.ai/reviews/520796 systematic literature review software. The process adopted a two-stage screening sequence. Based on the "keywords for include" and "exclude" features in Rayyan.ai, the risks of bias during the screening process were reduced while achieving quality. In line with the developed protocol and operationalized keywords in Rayyan.ai, after detecting possible duplicates and resolving them, the first screening stage was carried out with a focus on titles and abstracts, followed by the second stage, which screened full texts by reading them when considered to be relevant.

2.5. Data Extraction

In line with the protocol, studies seen to be relevant and consistent with the inclusion criteria were extracted for review in line with the RQs. However, an independent search or

snowballing was carried out to capture relevant articles that were not retrieved previously, to avoid excluding data that met the review inclusion criteria. Figure 3 shows the flow diagram of the final studies included for the systematic review of the literature, which were first analyzed under various headings, such as title, methodology, aim, findings, and recommendation. However, these are not presented in the manuscript. For a synchronized tabular presentation, a further review was conducted with headings limited to the author, location, themes, conceptual contributions, strengths of the study, limitations, and summary, as shown in Table 2. The results of this process are described in Section 3.

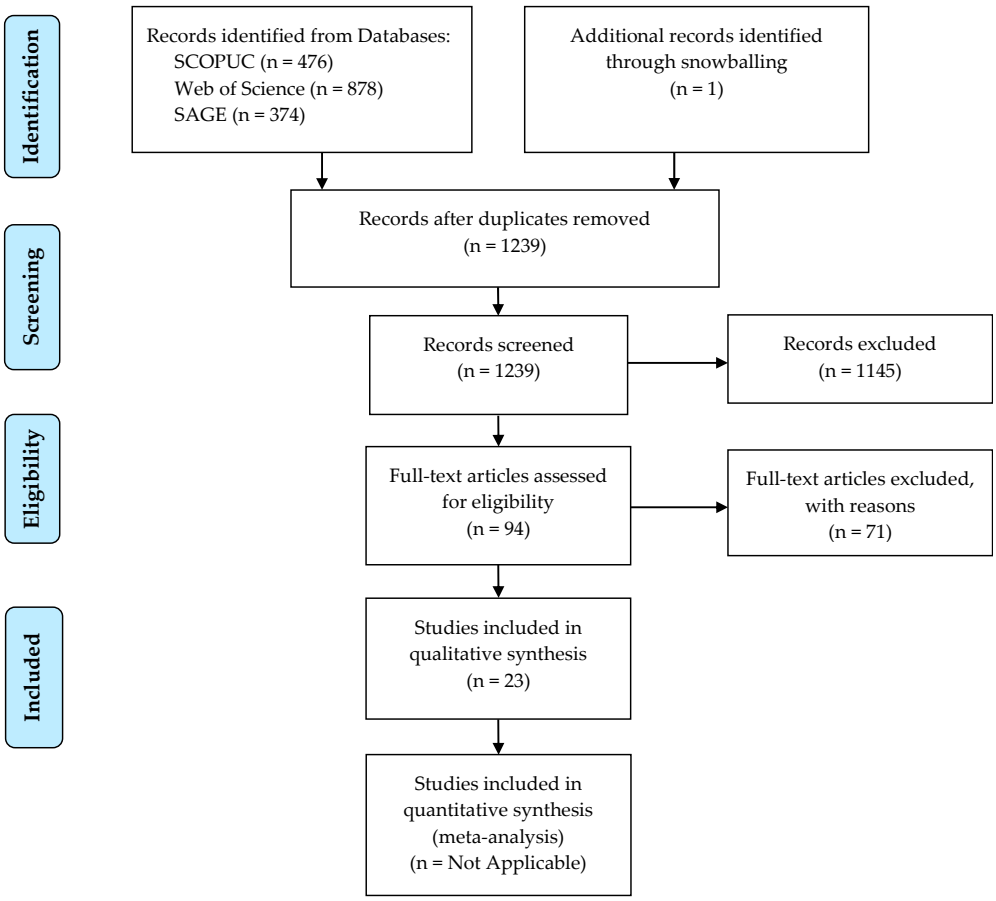

Figure 3. PRISMA flow diagram.

Table 2. Summary of key aspects of included and reviewed papers.

Authors	Location	Themes	Conceptual Contribution	Strengths	Limitations	Summary
Joshi (2019) [46]	• Uganda	• Sustainability • Environmental • Income status • MSW generation	• Sustainability • CE model • Weighted metric • Decentralized MSWM	• Identification of regions with potential benefit from CE • Focus on Africa	• Lack of explanation to justify the included indicators	• Wide range of relevant indices for CE transition. • Identification of regions with plastic waste availability. • CE can be integrated through recycling and thermal decomposition [46].
Ali (2022) [47]	• Pakistan	• Organic waste • Socioeconomic • Behavioral • Bureaucratic	• Multi-Criteria Decision Making (MCDM)	• Detailed outline of CE transition barriers or impediments • Focus on developing countries	• Techniques for evaluating and overcoming MSWM impediments are not discussed	• Food waste leads to messy environment. • Unesthetic society. • The availability of food waste is voluminous in developing countries; hence, CE model can be harnessed [47].
Peiris (2022) [48]	• Sri Lanka	• Circular economy • Environmental impacts • Resource management	• Life Cycle Assessment (LCA) • Business-As-Usual (BAU) • Emission Quantification Tool (EQT)	• Identification of local SWM to include incineration, sanitary landfill, recycling, and anaerobic digestion	• Absence of identified stakeholders in line with integrated sustainable MSWM • MSW collection approach is not clearly stated	• EQT concept enabled a validated emission analysis as a valuable tool for planning, sustainable MSWM, and decision making for CE in developing countries. • LCA was revealed as a tool for policy makers towards achieving alternatives to traditional MSWM and mechanisms for value creation [48].
Debrah (2022) [49]	• Africa	• Sustainability • Circular economy • Linear MSWM	• Integrative Research Approach • United Nations SDGs • Circular economy	• Outlined barriers mitigating MSWM transition from LE to CE	• Data analyzed did not cover the entirety of Africa • Absence of data on CE in some African countries as CE concept is new to the region	• Detailed CE integration in relation to environmental, social, and economic benefits. • Inadequate national framework for SWM based on CE principle. • Lack of political will, poor funding, and poor educational awareness [49].

Table 2. Summary of key aspects of included and reviewed papers.

Authors	Location	Themes	Conceptual Contribution	Strengths	Limitations	Summary
Oh (2020) [50]	• Brazil • Indonesia • Nigeria	• Recovery • Circular economy • Governance • Blueprint	• Institutional Analysis and Development (IAD) framework • Resource management	• Policy initiatives, baselines, and action plans were discussed under IAD framework	• Nonavailability of data in Nigeria was an impeding factor to sustainable MSWM as compared to Brazil and Indonesia.	• IAD framework and resource management are instruments for implementation of MSW recycling/recovery and corrective measures for continuous improvements for sustainable MSWM from nuisance to a valuable resource [50].
Oyelola (2017) [51]	• Nigeria	• Waste streams • Government • Urbanization • MSW composition	• MSW characterization • Circular economy	• Long duration of study, implying good, representative sample collection • Validated study from highly populated LGAs	• Absence of detailed strategy for CE application in MSWM	• High percentage of organic waste generation. • Waste sorting at households should be initiated. • Waste reuse is feasible through recycling [51].
Ezeudu (2021) [52]	• Nigeria	• New concept • Circular economy • Waste pickers	• SWOT analytical concept	• Identification of the informal sector's contribution to MSWM • The study approach can be applied to similar demographic areas	• Concrete integrated MSWM link or roadmap was lacking	• CE implementation is deterred due to the absence of novel MSWM facilities such as engineered landfills, incinerators, and anaerobic digestion plants. • MSWM CE enablers include informal recycling/resource recovery activities [52].
Tamasiga (2022) [53]	• Developing countries	• Organic waste • Opportunities • Circular economy • Sustainability	• Bibliometric review • Frequency and cluster	• Identification of life cycle assessments, behavior of consumers, and material flow as enhancing factors for MSWM in developing economy	• Confined research based on search criteria. Hence, generalized idea on the subject was excluded	• Food waste prevention strategy is crucial to MSWM. • Supply chain monitoring will enable waste management [53].
Okafor (2020) [54]	• Nigeria	• Environmental policy • Sustainability • Legislation • Recycling	• Circular economy • Management of end-of-life tyres (ELT)	• CE application in the management of end-of-life tyres • Diversion of waste from dumpsites • Legislating EPR as MSWM tool	• EPR policy does not fully consider awareness for implementation, which can be said to be a barrier	• Detailed ELT management at the regional, state, and LGA levels in Nigeria will boost recycling practices. • Private sector inclusion in MSWM [54].

Table 2. Summary of key aspects of included and reviewed papers.

Authors	Location	Themes	Conceptual Contribution	Strengths	Limitations	Summary
Ezeudu (2019) [55]	• Nigeria	• Sustainability • Circularity principle • Environmental policy • WEEE	• Circular economy • Competitive analysis	• Identification of dominant MSW-generating sectors	• CE framework is non-existent in Nigeria • Developing CE blueprint on specific sector basis will be essential	• High percentage of MSW generated in Nigeria has marketable and reusable value [55].
Al-Salem (2022) [56]	• Kuwait	• Implementation • Material flow • Valorization • Segregation	• Literature review • Extended Producer Responsibility (EPR)	• E-waste management • Waste stream availability • Economic value of waste • Revenue generation from waste	• More applicable to e-waste-dominated regions	• E-waste management is a gateway for a proper CE scheme. • The design of a modern waste valorization system reduces environmental burdens. • Sustainable MSWM will promote diversification of revenue generation [56].
Mihai (2022) [57]	• Rural areas (globally)	• Plastic waste • Pollution • Circular economy • Middle-income nations	• Proxy analysis of peer-reviewed literature	• Focus on MSWM in neglected rural communities • Major consideration of plastic waste streams • Identified measures for public health threat reduction	• Direct application of MSW plastic component flow and quantity within specific communities, which may not apply to others	• MSWM is given little consideration in rural areas. • Upcycling and the use of plastic fractions in building materials such as eco bricks, paving stones, and roof tiles are included in CE model and are practical methods of MSWM in middle-income societies. • EPR policy implementation is a sustainable approach to MSWM [57].
Ofori (2021) [58]	• Ghana	• Developing countries • Sustainability • Behavior • Household waste	• Structured questionnaires analyzed using partial least squares concept • Perceived behavioral control (PBC)	• Integrated sustainable waste management (ISWM) capturing all stakeholders	• Mixed-methods approach of study could give an in-depth solution beyond qualitative methods used • Longitudinal studies could offer insight beyond self-reports as adopted	• Based on ISWM, e-waste management is a collective responsibility. • EPR policy is a tool for effective e-waste management [58].

Table 2. Summary of key aspects of included and reviewed papers.

Authors	Location	Themes	Conceptual Contribution	Strengths	Limitations	Summary
Oyebode (2022) [59]	• Nigeria	• Energy generation • Resource conservation • Upcycling • Waste minimization	• Site-specific approach • Literature review	• Wide range of approaches to MSWM beyond the current linear economy system	• Planning and maintenance of MSWM facilities are necessary. However, such facilities are scarcely available in Nigeria.	• Government has major roles in providing enabling laws, guidelines, and functional MSWM system. • The quantity of MSW generation is rapidly increasing. • MSW available has energy generation potential [59].
Wikurendra (2022) [60]	• Developing countries	• Circular economy • Developing countries • MSWM • Linear economy	• Systematic review • Hybrid assessment (SWOT analysis)	• Obstacles mitigating the transition from LE to CE in MSWM in developing countries are detailed	• Implementable approach to MSWM in the context of CE in developing economy	• 3Rs of reduce, reuse, and recycle are approaches for MSWM in developing countries. • Improved MSW collection will enhance CE actualization [60].
Babayemi (2017) [61]	• Nigeria	• Economic opportunities • MSW generation • MSW collection • Behavior of residents	• Material flow • End of life • Composting • Low-end handling • Recycling	• Inclusion of data from other African countries in the study • Inclusion of all categories of waste	• MSW generation, components in percentages, and collection rate in Nigeria were lacking	• MSW is in abundance in developing countries. • Potential benefits of MSW utilization are high. • Huge entrepreneurial and economic opportunities exist in the MSWM sector. • Inefficient MSW collection system [61].
Paes (2021) [62]	• Brazil	• Public policies • Developing countries • Circular economy	• Circular economy concept • Scaling of economic and environmental benefits	• Wide range of study within multiple municipalities	• Findings are specific to the study area based on the data analyzed	• Sustainable MSWM can be achieved through effective policies covering waste generation, collection, transportation, sorting, treatment, and safe disposal. • Public awareness of MSWM [62].

Table 2. Summary of key aspects of included and reviewed papers.

Authors	Location	Themes	Conceptual Contribution	Strengths	Limitations	Summary
Márquez (2020) [63]	• Colombian	• MSWM drivers • Circular economy • Public policy implementation • Legal framework • Restructuring	• Case-study-based concept • Sustainability	• Historical and case-study-based analysis • Inclusive and exemplary research for other emerging economies	• Lack of formulation of MSWM approaches inclusive of private sector participation	• Financial sustainability and inclusive recycling are sustainable approaches to MSWM. • Public policy implementation and review. • Integrated sustainable MSWM is a driver of CE [63].
Mokuolu (2021) [64]	• Nigeria	• Circular economy • Nigeria • MSW segregation	• Waste audit including identification, characterization, and segregation	• Research covered MSWM in healthcare facilities • Safety in waste handling • Health and environment	• No identified roadmap of CE approach for MSWM	• LE model of MSWM in practice. • Absence of waste separation bins. • Considerable level of MSWM awareness. • Open burning of waste [64].
Amasuomo (2016) [65]	• Nigeria	• Environmental awareness • Nigeria • Inappropriate technology	• Peer-reviewed publication	• Real MSW situational analysis • Holistic and integrated approach to MSWM	• Generalized approach, no practical roadmap for transitioning from the current trend	• MSWM is a major concern in Nigeria. • Inadequate environmental policies and legislations. • Low level of environmental awareness. • Poor funding and inappropriate technology. • Unplanned MSWM system [65].
Salguero-Puerta (2019) [66]	• Togo	• Recycling • Circular economy • Linear economy • Waste composition	• Fieldwork (waste audit) • Evaluation of CE indicators	• Identification of the potential of available MSW within the study area • Monetary estimation of the benefits of MSW utilization • Percentage estimates of various MSW components	• The waste generated within the campus may vary from that generated within local community, meaning that a comparative evaluation will be necessary	• Suitable MSWM processes are composting and thermal methods. • CE paradigm can be integrated through reuse of recyclables, bio-gasification of biodegradables, and selling of sorted valuable waste items. • Educating the public and promoting environmental awareness [66].

Table 2. Summary of key aspects of included and reviewed papers.

Authors	Location	Themes	Conceptual Contribution	Strengths	Limitations	Summary
Oba (2015) [21]	• Nigeria	• Scrap tyres • SWM • Nigeria • Waste utilization	• Sample collection, laboratory analysis, and material suitability test (particle size distribution, Marshall stability test)	• Elimination of dumpsites for MSW disposal • Entrepreneurial opportunities • Job and wealth creation avenue	• Absence of a framework for government and public sector involvement beyond the academic research	• Scrap tyre MSW can be reused for infrastructural development. • Waste minimization can be achieved through CE integration. • Recycling and environmental sanitation can be enhanced [21].
Wang (2021) [67]	• China	• Implementation • Sorting • Domestic waste • Policy	• Secondary data analytical concept • Sample collection and laboratory test	• Usefulness of policy implementation • Transition from LE to CE through nontechnological approach	• Unavailability of data in some developing economies could hinder the actualization of the same approach • Demography and behavioral patterns of residents may affect the outcomes of the policy elsewhere	• The reintroduction of the waste-sorting rule has caused a sharp decline in residual waste generation. • Enabled effective waste classification, leading to energy resource recovery, waste incineration, and anaerobic digestion as sustainable MSWM processes [67].

3. Results

Figure 4 shows the trends of the research based on the topic from 2008 to 2022. The trend in relation to the dynamics of research in the subject area is based on the formulated RQs, concept, and search strategy. The dynamics of the graph covering research conducted between 2008 and 2022 are indicative of scholarly activities and contributions on this topic, from which it can be seen that the concept of CE was less studied in the context of this paper until 2017, with a decline in 2018. However, as illustrated in Figure 4, interest in this research area has experienced an increase over recent years prior to 2022.

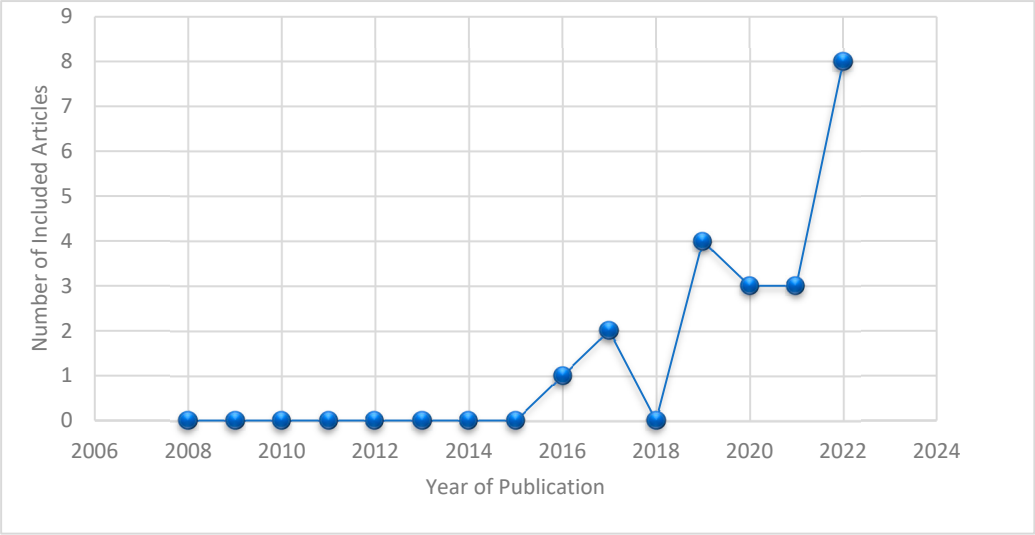

Figure 4. Results of included research from databases between 2008 and 2022.

The outcomes of the findings from the 23 studies that were systematically reviewed are presented in Table 2, based on a further critique and summary with a focus on various specific headings to obtain detailed outcomes in line with the RQs. Based on this summarized tabular presentation, further discussion can be seen in the subsequent Section 4.

3.1. Location

Figure 5 shows the various locations of all the papers included for review. In the various categories, Nigeria is predominantly featured in 10 of the papers reviewed, which account for 40%. Other countries, as shown in Figure 5, presented relevant studies based on the search strategy and inclusion criteria, wherein comparisons were made with respect to the study area of Nigeria. However, the situation in Nigeria points to the untapped CE potential in the MSWM system. This is evident in the volume of generated MSW composed of various components. The interest of professionals in contributing meaningfully to this subject area has risen [2,20,55]. However, there are still a number of hindering factors, such as poor funding, a lack of planning, low political will, a lack of infrastructure, the absence of waste data, the failure of governance, and the non-engagement of professionals adequately in the waste management sector [52,58,61,65]. The MSWM situation in Nigeria is not different from that of other developing countries, as identified from the studies included [11,46,49]. However, as identified in some included studies in this SLR, ideas can be adopted based on the lean principle from countries with functional and sustainable MSWM systems, such as China, the USA, and OECD countries, where dumpsites for the disposal of MSW are not in existence, extended producer responsibility (EPR) is operational, and the participation of non-governmental bodies, the implementation of sustainable frameworks, and the provision of technological infrastructure for MSWM can be observed [36,38,41,42].

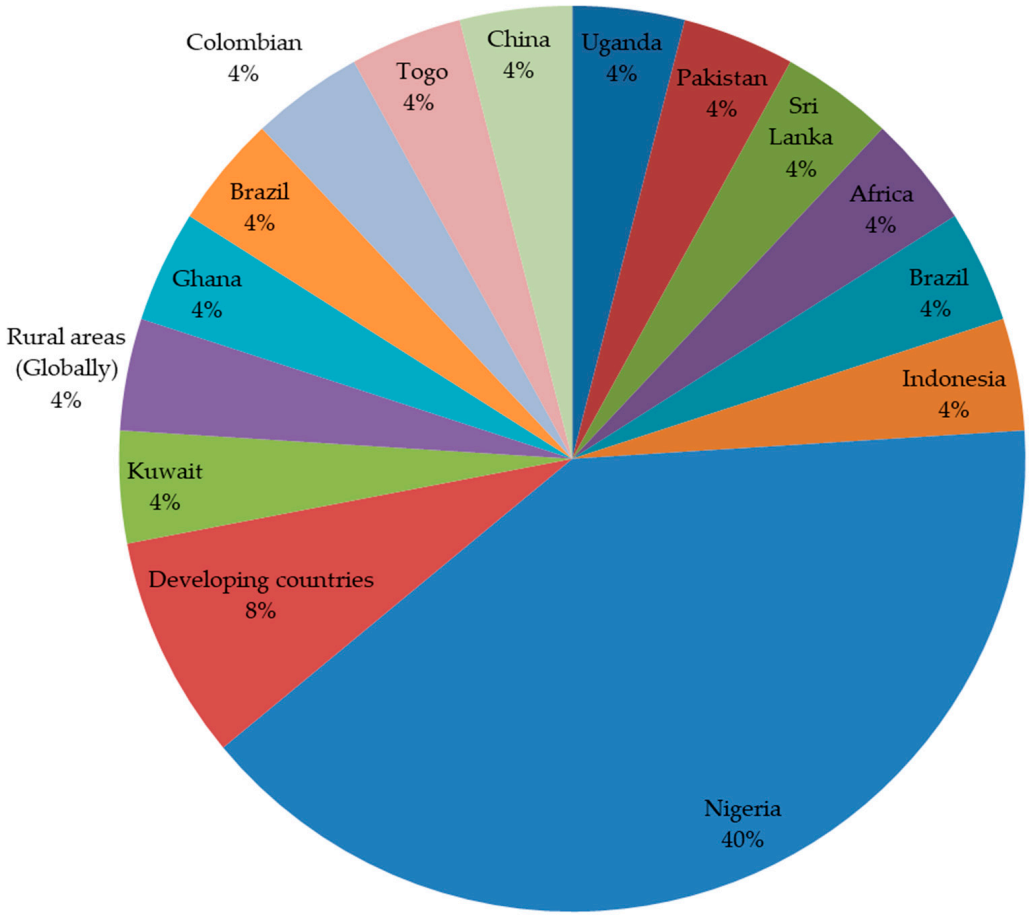

Figure 5. Locations considered.

3.2. Themes

Based on the included studies, Figure 6 presents some key themes in percentages in a pie chart. The most frequent theme appeared in 20 papers, accounting for 28%, and it was related to MSW or resource management, which included the various ways in which waste was sorted (including the activities of informal pickers) and collection processes. This was followed by three themes that were broadly similar in their inclusion across the various papers considered, which were the circular economy (10 papers), accounting for 14%; MSW generation and composition streams (10 papers), accounting for 14%; and bureaucratic/governance and policy (9 papers), accounting for 13%. Others can be seen in Figure 6.

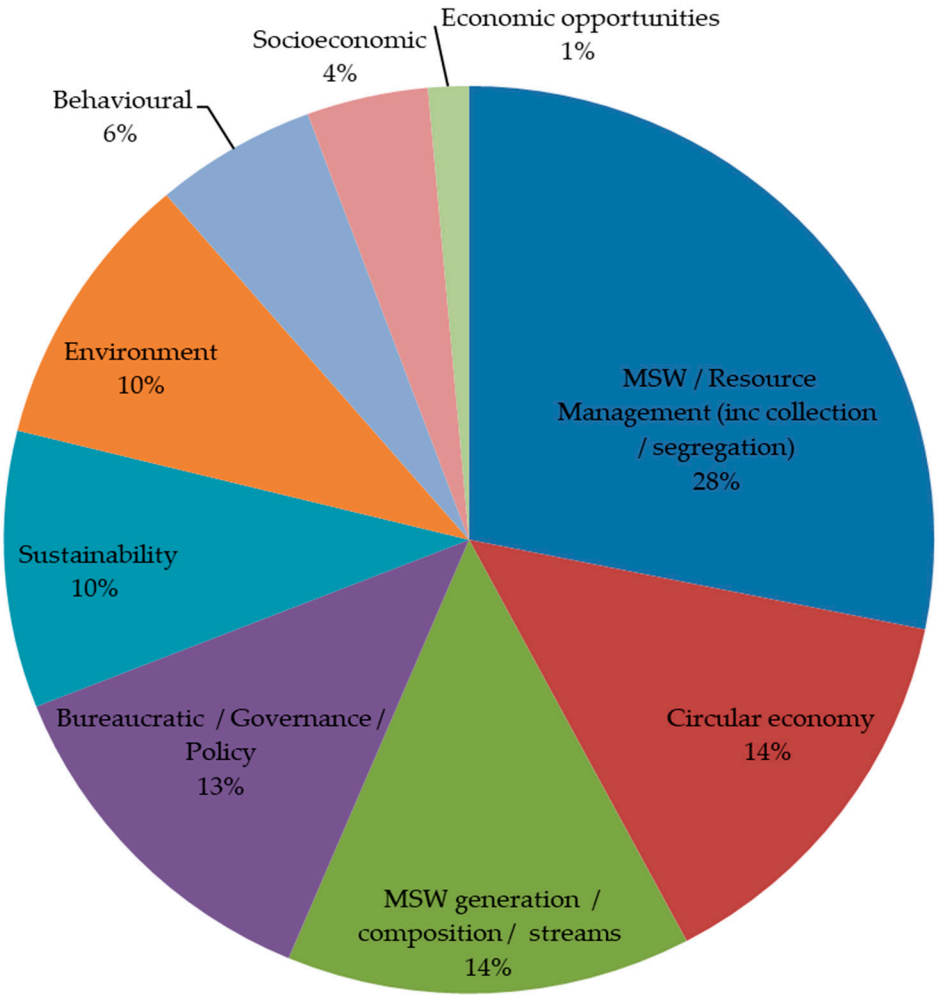

Figure 6. Themes considered.

3.3. Methods Adopted

Based on the methods adopted in the reviewed papers presented in Figure 7, evidently, the most frequently adopted method was the use of a case study (18 papers), which accounted for 39%, followed by the use of secondary data (7 papers), which resulted in 15%, an analysis of the peer-reviewed literature by a critical/systematic literature review (6 papers), accounting for 13%, and a SWOT analysis (2 papers), equating to 5%. Primary data collection by fieldwork (3 papers), lab testing (3 papers), and structured questionnaires (1 paper) was less well considered. A range of other approaches could be seen, which included, but were not limited to, LCA (1 paper) and MCDA (1paper). According to the above-identified adopted methods, the research that led to this SLR offers an insight into the salient gaps in existing studies in MSWM, which will be addressed in the main research following the findings that have been obtained from this SLR. This is because most MSWM research is focused on secondary data, despite being case-study-based; the main research that will utilize the outcomes of this SLR will be case-study- and site-based, with MSW samples collected and a waste audit conducted to overcome the issue of a lack of knowledge of MSW component compositions in terms of proportions and the absence of accurate MSW data [4,24], especially within the region of focus. The approach will adopt engineering principles throughout the projected design period for futuristic planning, aimed at developing a framework based on the components of MSW that are found to be prominent within the city, for the actualization of a sustainable MSWM system.

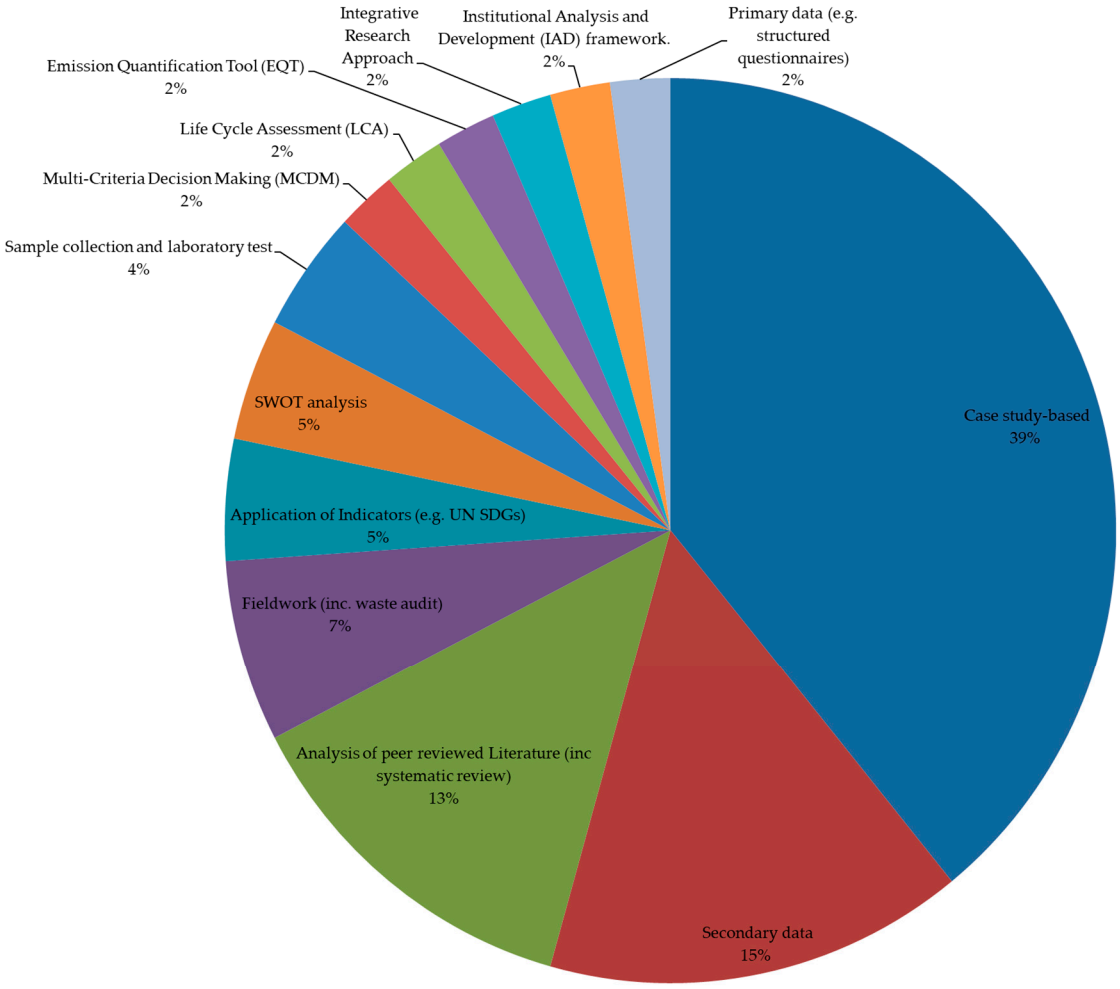

Figure 7. Methods adopted.

Placing the results presented above in perspective, and in connection with the RQs aimed at investigating indicators that enhance CE implementation, the identification of key enablers and barriers impeding CE integration, and the current practices of MSWM in Nigeria, a discussion of the results is developed in the next section under four subheadings targeted at transitioning in the management of MSW from LE to CE, following a summary of the key aspects of the reviewed papers.

4. Discussion

This section discusses the findings and the results obtained from the included and reviewed studies in the systematic review of the literature by providing answers to each of the four RQs. These are addressed under subheadings including indicators, enablers, and barriers to CE transition and implementation in MSWM systems in relation to the current practices of waste management in Nigeria.

4.1. Indicators

The availability of MSW composed of various components in large quantities, to the extent that the natural environment is unable to absorb and regenerate such voluminous waste, is a strong and evidential indicator encompassing both technical and biological materials [66,68,69]. Figure 8 presents the composition of the prominent MSW components available in percentages within some Nigerian cities. This is an indication that composting, recycling, and upcycling can be achieved in line with the CE model. Records of huge volumes of vehicle scrap tires (VST), estimated at over eight hundred and fifty thousand

annually, are an indicator of the CE opportunities in Nigeria, which, if harnessed, will promote socioeconomic activities and waste regeneration. This could lead to the manufacturing of new products from such MSW, especially as VST, which, if proportionally processed, can serve as a replacement material in asphaltic concrete for roof and pavement construction [21]. This approach will go beyond creating an enabling and livable society to commercial viability and environmental sustainability, while achieving sustainable MSWM in the context of CE [54,70–73].

Electronic waste (E-waste), or waste electrical and electronic equipment (WEEE), is another key indicator of the availability of waste streams wherein a sustainable MSWM system can be achieved. Africa in general, and Nigeria in particular, is among the prime destinations for e-waste, and, with an appropriate policy framework, regulation, and functional waste management system, the integration of circularity will create economic, social, and environmental benefits [74,75]. The improved MSWM in Lagos State is an exemplified indication of the opportunities of a CE transition as plastic and other non-biodegradable waste components are pelletized, and a gradual resource conservation initiative can be implemented through the adoption of Reduction, Reuse, Recovery, and Recycling (4Rs) in the MSWM system [20,67,76]. These are some strategies that are indicative of the potential opportunities of CE in transforming waste into valuable resources through waste-to-wealth and renewable energy generation advancement [8,21].

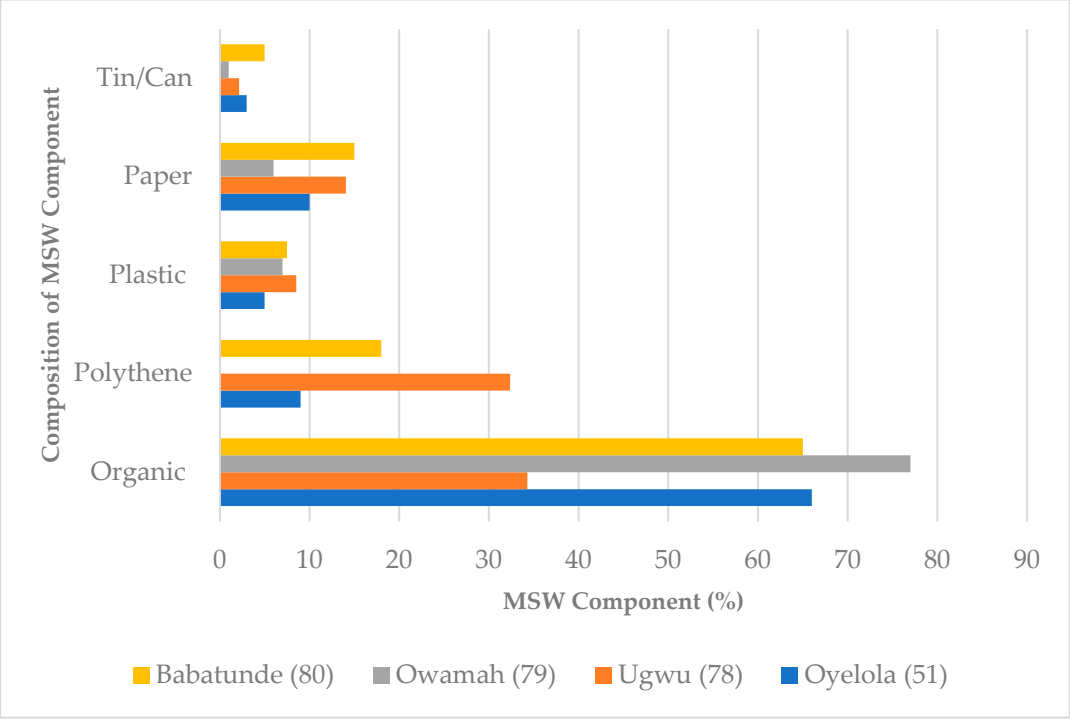

Figure 8. Composition of prominent MSW components in Nigeria [51,77–79].

4.2. Enablers

The perceptions of residents to consider and regard waste as a valuable resource is a blueprint for the actualization of CE on the premise of integrated sustainable waste management (ISWM) within developing countries. This is because ISWM relies on a waste hierarchy including stakeholders (citizens, government, non-governmental organizations, and institutions) and the environment (financial, infrastructure, economic and social inclusion) [50,80]. With these factors under consideration, the MSWM transition towards circularity is feasible. Waste valorization, waste sorting at the source of generation, a willingness to adopt recycling, reuse, W-t-E, and the existence of informal waste pick-

ers, as well as active institutional collaboration, are some enabling factors towards CE integration [52,67,81].

Additionally, the initiative of non-state actors in waste management co-production, which has yielded appreciable results through the introduction of increased public awareness, information communication technology (ICT) utilization, and the awarding of grants, has reoriented stakeholders and can be seen as a CE enabler. The potential of waste as a resource, which in turn has created interest in the sector, is another enabling factor. In light of the above, some other promotional and enabling activities include pearl recycling, which focuses on waste recovery and conversion; Wecyclers, which is concerned with recycling; OkwuEco, which specializes in connecting residents with merchants to trade recyclable materials via a mobile app; and Hinckley recycling of e-waste [82].

However, the situation in Nigeria is far from expectation; the current MSWM practices can be improved only if the challenges of poor funding, a lack of government commitment, political unwillingness, the unavailability of MSW data, poor knowledge of CE, and weak policies [49] are overcome. Moreover, MSW sorting, handling, collection, and appropriate disposal are cardinal in the transition to CE [83], thereby increasing the percentage of MSW collection from 20% [2]. Public–private partnership (PPP) inclusion on a full scale has been identified as a key enabler in achieving CE integration in MSWM [58].

The transition to CE in the MSWM sector can be enabled through a regulated roadmap, a functional framework, trained waste managers, coordination, and synergy among the agencies responsible for MSWM, as well as an efficient transportation planning system, populace orientation, and stakeholders' participation [84]. These enablers are rare or non-existent in the country under focus [11,54]. Summarily, some enablers that can enhance the adoption of CE in the MSWM system in Nigeria are the formalization of informal recycling/resource recovery activities and waste management policies with established institutions [52].

4.3. Barriers

Owing to several reasons highlighted by the results obtained in the reviewed papers, the barriers preventing the MSWM system from transitioning from LE to CE are enormous and some of them are a lack of waste data, poor waste handling and disposal habits, the absence of waste sorting at the source of generation, weak policy on EPR in view of MSWM, a lack of technological infrastructure, limited coverage of waste collection, poor funding, a lack of political will, the unsuccessful establishment of a formal recycling system, the appointment of non-resource persons to manage the waste sector, and the weak implementation of environmental regulations [49,52,85–87]. Barriers associated with the waste management sector are multifaceted and can be categorized as technical, behavioral, institutional, socio-cultural, financial, policy/legal, political, and demographic [14]. With reference to the reviewed literature and in order of severity, weak legislation, a lack of government commitment, a lack of political will, poor funding, the non-engagement of professionals, the absence of infrastructure, the lack of strategic planning, weak institutional collaboration, uncivilized behavioral conduct, and demography are major barriers to sustainable MSWM in Nigeria [14]. Therefore, if these can be given priority, starting with the most severe, the country can enter the path of transition from LE to CE in the management of generated MSW. However, given the assertion that MSW crises are mostly caused by the increase in rural–urban migration, population growth, and industrial, economic, and social activities [87,88], these can be regarded as tertiary factors as no municipality is devoid of MSW generation. Rather, a well-planned and functional MSW management system would represent a foundation to achieve sustainable MSWM practices, and Nigeria can transition from an LE to a CE model by taking this into consideration. This can be justified through strong collaboration between the informal and formal government agencies and private entities [47,55], legislation and policy implementation [48,54], funding and behavior adjustment [47], and technology and infrastructural provision [55].

4.4. Current Practice

For sustainable MSWM to be achieved, the various stages and processes comprising waste generation, namely sorting, segregation, characterization, storage, collection, transfer and transportation, treatment or processing, and disposal, must be effective and operational [89,90]. However, the current practice of MSWM in Nigeria is contrary to the above, as the waste generated is not segregated, and the waste collected is group together and disposed of at dumpsites without treatment [18]. Figure 2 demonstrates this. The MSWM practice in Nigeria is characterized by indiscriminate and open dumping. Waste in most cities is littered in drain systems, water ways, and on major roads [10].

Failures leading to the poor practice of MSWM can be attributed to the dysfunctional waste management authority, resulting in the proliferation of open dumping at undesignated places [91]. In essence, MSWM is coordinated and managed at the state level in Nigeria by contractors [10]. Services provided by these contractors are limited to certain areas within the urban city, which leaves residents within the low-income and rural areas of the city responsible for the management of their generated waste, thereby leading them to dispose of waste at any available location, such as in water channels, burying it in the ground, and open burning [92].

In developing countries, 30% to 60% of MSW is uncollected, and less than 50% of residents benefit from waste management services, thereby making indiscriminate dumping and open burning a predominant MSWM practice [93,94]. These practices are similar to the current situation in Nigeria, wherein, rather than complying with the most environmentally favorable waste management hierarchy in the sequence of avoid, reduce, reuse, recycle, energy recovery, treat, and dispose [95], the practices are dominated by the environmentally unfavorable option of dumpsite disposal. Although some improvements have been made in the waste management sector, it is not satisfactory with regard to the expectations of MSWM best practices [12,65,96,97]. It is promising, however, that the current situation of MSWM in some parts of Nigeria is witnessing some level of improvement in terms of landfill infrastructure [12], as well as the pelletization of plastic waste components [20] and informal waste sorting [61]. A great deal of work is still required in addressing the main barriers that exist. One key step is to identify waste streams, categorize waste types, and identify high-value materials—this includes the energy value of waste, should waste-to-energy be considered. This will be a key focus in future research.

5. Conclusions

A systematic review of the literature aimed at investigating the current practices of MSWM in Nigeria, with the goal of considering the transition and implementation of CE in the MSWM system, is presented. The research developed a strategic search string, and 23 studies suitable for inclusion based on the RQs, which focused on factors such as indicators, enablers, and barriers to CE integration in the management of MSW, were reviewed. Findings reveal that the status of MSWM within the study area is poor, as MSW is disposed of at dumpsites, and the collection rate is very low and characterized by poor planning and scheduling of transportation facilities for communal waste transfer. The full cycle of MSWM, which comprises generation, handling, collection, transportation, recycling, treatment, recovery, and disposal, is not effectively practiced in most municipalities within the country.

Although preliminary knowledge of CE exists, the nascent application of some key sustainability principles, such as the acknowledgement of waste as a resource, informal waste picking activities, recycling, and composting application, are indicators of a potential paradigm shift towards CE in the MSWM system. Moreover, the various components of MSW generated in large quantities is an indication that the CE model could be successful, as these waste components constitute raw materials that can be utilized technically and biologically in line with CE principles. The assiduousness of researchers and environmental professionals in contributing meaningfully towards achieving a sustainable environment is an evidential indicator in respect to CE transition.

Some enablers identified are the perception of the populace to consider waste as a valuable resource, which is an indicator of CE actualization on the premise of integrated sustainable waste management (ISWM); this is because behavioral conduct can enable or militate the transition from LE to CE. In essence, the indicators and enablers are interwoven considering the activities of the informal sector's waste recyclers, who are promoting the operation of 3Rs. Findings reveal that collaboration between stakeholders such as the government and non-governmental organizations and environmental institutions will activate a swift transition to CE in the MSWM sector. The barriers identified from the review that hinder CE transition in MSWM are numerous, and key among them, in order of severity, are weak legislation, a lack of government commitment, a lack of political will, poor funding, the non-engagement of professionals, the absence of infrastructure, a lack of strategic planning, weak institutional collaboration, uncivilized behavioral conduct, and location factors.

The review noted that field-based research based on waste auditing and characterization is scarcely conducted; the non-availability of MSW data can be overcome when such primary research is conducted, beyond merely conducting a case study of an area, as was often seen in the reviewed papers. In terms of suggestions, the review therefore encourages a holistic approach in the design of a sustainable MSWM system, with applicability to every municipality, to ascertain the composition of MSW within each municipality. This will give insights into the most appropriate CE model in the regeneration of the available MSW in each locality. Moreover, effective legislation, pragmatic governance, funding availability, a synergy with professionals and non-governmental bodies, the provision of infrastructure, technology, strategic planning, and educational awareness will be beneficial in the actualization of sustainable MSWM in line with circularization. Finally, pending the availability of novel infrastructure, a successful roadmap can be achieved through the implementation of the 3Rs and 12Rs as a transitionary measure to CE, as in the case of the United States of America, Europe, and China. Considering the level of CE awareness in the country, a well-established framework for the integration and adoption of the CE model should be developed while targeting the abolishment of the LE model.

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Abbreviations

3Rs	Reduce, Recycle, and Reuse
CE	Circular Economy
ELTs	End-of-Life Tires
EPR	Extended Producer Responsibility
E-Waste	Electronic Waste

ISWM	Integrated Sustainable Waste Management
KG/P/D	Kilogram Per Person Per Day
LCA	Life Cycle Assessment
LE	Linear Economy
MFA	Material Flow Analysis
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
PPP	Public–Private Partnership
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RQs	Research Questions
SAMTAB	Source, Appearance, Method, Timeliness, Applicability, and Balance
SDGs	Sustainable Development Goals
SON	Standard Organization of Nigeria
SLR	Systematic Literature Review
SWM	Solid Waste Management
SWOT	Strength, Weakness, Opportunity, and Threat
UN	United Nations
VST	Vehicle Scrap Tires
WEEE	Waste Electrical and Electronic Equipment

Appendix A

Table A1. PRISMA Checklist 2009.

Section/Topic	No.	Checklist Item	Reported under Section
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Title
Abstract			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Abstract
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known.	1
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	1, 2
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	2
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	2
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	2
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	2
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	2

Table A1. *Cont.*

Section/Topic	No.	Checklist Item	Reported under Section
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	2
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	2
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	2
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	N/A

References

1. Ndou, V.; Rampedi, I.T. Bibliometric Analysis of Municipal Solid Waste Management Research: Global and South African Trends. *Sustainability* **2022**, *14*, 10229. [CrossRef]
2. Kaza, S.; Yao, L.C.; Bhada-Tata, P.; Van Woerden, F. *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*; World Bank: Washington, DC, USA, 2018.
3. Öztaş, S.; Bektaş, N. Sustainable Municipal Solid Waste Management with Zero Waste Approach. In Proceedings of the International Conference on Natural Resources and Sustainable Environmental Management, Riga, Latvia, 1 November–31 October 2022.
4. Plastinina, I.; Teslyuk, L.; Dukmasova, N.; Pikalova, E. Implementation of Circular Economy Principles in Regional Solid Municipal Waste Management: The Case of Sverdlovskaya Oblast (Russian Federation). *Resources* **2019**, *8*, 90. [CrossRef]
5. Batlles-De-La-Fuente, A.; Belmonte-Ureña, L.J.; Plaza-Úbeda, J.A.; Abad-Segura, E. Research Trends of the Management of Solid Waste in the Context of Circular Economy. In *Handbook of Solid Waste Management: Sustainability through Circular Economy*; Springer: Singapore, 2020; pp. 1–33.
6. Vergara, S.E.; Tchobanoglous, G. Municipal Solid Waste and the Environment: A Global Perspective. *Annu. Rev. Environ. Resour.* **2012**, *37*, 277–309. [CrossRef]
7. Hirpe, L.; Yeom, C. Municipal Solid Waste Management Policies, Practices, and Challenges in Ethiopia: A Systematic Review. *Sustainability* **2021**, *13*, 11241. [CrossRef]
8. Misbah, M.S.Y.; Raheel, H. From Trash to Treasure the Thermochemical Conversion of Garbage into Biofuel. In Proceedings of the 1st International Conference on Chemical, Petroleum, and Gas Engineering, Alkhoms, Libya, 20–22 December 2016.
9. Kehinde, O.; Ramonu, O.; Babaremu, K.; Justin, L. Plastic wastes: Environmental hazard and instrument for wealth creation in Nigeria. *Heliyon* **2020**, *6*, e05131. [CrossRef]
10. Nnaji, C.C. Status of municipal solid waste generation and disposal in Nigeria. *Manag. Environ. Qual. Int. J.* **2015**, *26*, 53–71. [CrossRef]
11. Aliu, I.R.; Adeyemi, O.E.; Adebayo, A. Municipal household solid waste collection strategies in an African megacity: Analysis of public private partnership performance in Lagos. *Waste Manag. Res.* **2014**, *32*, 67–78. [CrossRef]
12. Ezeudu, O.B.; Agunwamba, J.C.; Ugochukwu, U.C.; Ezeudu, T.S. Temporal assessment of municipal solid waste management in Nigeria: Prospects for circular economy adoption. *Rev. Environ. Health* **2021**, *36*, 327–344. [CrossRef]
13. Ezeudu, O.B.; Ezeudu, T.S.; Ugochukwu, U.C.; Tenebe, I.T.; Ajogu, A.P.; Nwadi, U.V.; Ajaero, C.C. Healthcare Waste Management in Nigeria: A Review. *Recycling* **2022**, *7*, 87. [CrossRef]
14. Yukalang, N.; Clarke, B.; Ross, K. Barriers to Effective Municipal Solid Waste Management in a Rapidly Urbanizing Area in Thailand. *Int. J. Environ. Res. Public Health* **2017**, *14*, 1013. [CrossRef]
15. Simatele, D.M.; Dlamini, S.; Kubanza, N.S. From informality to formality: Perspectives on the challenges of integrating solid waste management into the urban development and planning policy in Johannesburg, South Africa. *Habitat Int.* **2017**, *63*, 122–130. [CrossRef]
16. Ogundele, O.M.; Rapheal, O.M.; Abiodun, A.M. Effects of Municipal Waste Disposal Methods on Community Health in Ibadan—Nigeria. *Polytechnica* **2018**, *1*, 61–72. [CrossRef]
17. Godfrey, L.; Ahmed, M.T.; Gebremedhin, K.G.; Katima, J.H.; Oelofse, S.; Osibanjo, O.; Richter, U.H.; Yonli, A.H. Solid Waste Management in Africa: Governance Failure or Development Opportunity? In *Regional Development in Africa*; IntechOpen: London, UK, 2019; Volume 235. [CrossRef]

18. Salami, H.A.; Adegite, J.O.; Bademosi, T.T.; Lawal, S.O.; Olutayo, O.O.; Olowosokedile, O. A Review on the Current Status of Municipal Solid Waste Management in Nigeria: Problems and Solutions. *J. Eng. Res. Rep.* **2018**, *3*, 1–16. [CrossRef]
19. Abila, B.; Kantola, J. Municipal solid waste management problems in Nigeria: Evolving knowledge management solution. *Int. J. Environ. Ecol. Eng.* **2013**, *7*, 303–308.
20. Olukanni, D.O.; Oresanya, O.O. Progression in Waste Management Processes in Lagos State, Nigeria. *Int. J. Eng. Res. Afr.* **2018**, *35*, 11–23. [CrossRef]
21. Oba, A.L.; Onungwe, I.; George, A.G.; Amgbara, T.O.; Akpan, P.P. Waste to Wealth; The Utilization of Scrap Tyre as Aggregate in Bituminous Mixes for Road Construction. *Int. J. Eng. Res. Appl.* **2015**, *5*, 6–11.
22. Bianchini, A.; Rossi, J.; Pellegrini, M. Overcoming the Main Barriers of Circular Economy Implementation through a New Visualization Tool for Circular Business Models. *Sustainability* **2019**, *11*, 6614. [CrossRef]
23. Malinauskaite, J.; Jouhara, H.; Czajczyńska, D.; Stanchev, P.; Katsou, E.; Rostkowski, P.; Thorne, R.; Colón, J.; Ponsá, S.; Al-Mansour, F.; et al. Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe. *Energy* **2017**, *141*, 2013–2044. [CrossRef]
24. Sharma, H.B.; Vanapalli, K.R.; Samal, B.; Cheela, V.S.; Dubey, B.K.; Bhattacharya, J. Circular economy approach in solid waste management system to achieve UN-SDGs: Solutions for post-COVID recovery. *Sci. Total Environ.* **2021**, *800*, 149605. [CrossRef]
25. Batista, M.; Caiado, R.G.G.; Quelhas, O.L.G.; Lima, G.B.A.; Filho, W.L.; Yparraguirre, I.T.R. A framework for sustainable and integrated municipal solid waste management: Barriers and critical factors to developing countries. *J. Clean. Prod.* **2021**, *312*, 127516. [CrossRef]
26. Ferronato, N.; Rada, E.C.; Gorritty Portillo, M.A.; Cioca, L.I.; Ragazzi, M.; Torretta, V. Introduction of the circular economy within developing regions: A comparative analysis of advantages and opportunities for waste valorization. *J. Environ. Manag.* **2019**, *230*, 366–378. [CrossRef]
27. Ander, E. *1-The OECD Inventory of Circular Economy Indicators*; OECD: Paris, France, 2021.
28. Van Fan, Y.; Klemeš, J.J.; Walmsley, T.G.; Bertók, B. Implementing Circular Economy in municipal solid waste treatment system using P-graph. *Sci. Total Environ.* **2020**, *701*, 134652. [CrossRef]
29. Llanes, J.L.; Kalogirou, E. Waste-to-Energy Conversion in Havana: Technical and Economic Analysis. *Soc. Sci.* **2019**, *8*, 119. [CrossRef]
30. Juárez-Hernández, S. Energy, environmental, resource recovery, and economic dimensions of municipal solid waste management paths in Mexico city. *Waste Manag.* **2021**, *136*, 321–336. [CrossRef]
31. FICCI, Accenture Strategy. *Accelerating India's Circular Economy Shift: A Half-Trillion USD Opportunity: Future-Proofing Growth in a Resource-Scarce World*; FICCI: New Delhi, India, 2018.
32. Mandpe, A.; Paliya, S.; Gedam, V.V.; Patel, S.; Tyagi, L.; Kumar, S. Circular economy approach for sustainable solid waste management: A developing economy perspective. *Waste Manag. Res.* **2023**, *41*, 499–511. [CrossRef]
33. Smol, M.; Duda, J.; Czaplicka-Kotas, A.; Szołdrowska, D. Transformation towards Circular Economy (CE) in Municipal Waste Management System: Model Solutions for Poland. *Sustainability* **2020**, *12*, 4561. [CrossRef]
34. Tsai, F.M.; Bui, T.-D.; Tseng, M.-L.; Lim, M.K.; Hu, J. Municipal solid waste management in a circular economy: A data-driven bibliometric analysis. *J. Clean. Prod.* **2020**, *275*, 124132. [CrossRef]
35. Negrete-Cardoso, M.; Rosano-Ortega, G.; Álvarez-Aros, E.L.; Tavera-Cortés, M.E.; Vega-Lebrún, C.A.; Sánchez-Ruíz, F.J. Circular economy strategy and waste management: A bibliometric analysis in its contribution to sustainable development, toward a post-COVID-19 era. *Environ. Sci. Pollut. Res.* **2022**, *29*, 61729–61746. [CrossRef]
36. OECD. *Waste Management, and the Circular Economy in Selected OECD Countries: Evidence from Environmental Performance Reviews*; OECD: Paris, France, 2019.
37. Marques, A.C.; Teixeira, N.M. Assessment of municipal waste in a circular economy: Do European Union countries share identical performance? *Clean. Waste Syst.* **2022**, *3*, 100034.
38. Kurniawan, T.A.; Liang, X.; O'callaghan, E.; Goh, H.; Othman, M.H.D.; Avtar, R.; Kusworo, T.D. Transformation of Solid Waste Management in China: Moving towards Sustainability through Digitalization-Based Circular Economy. *Sustainability* **2022**, *14*, 2374. [CrossRef]
39. Kamble, C.B.; Raju, R.; Vishnu, R.; Rajkanth, R.; Pariatamby, A. A circular economy model for waste management in India. *Waste Manag. Res.* **2021**, *39*, 1427–1436. [CrossRef]
40. Mihai, F.-C.; Ulman, S.-R. *Circular Economy in Green Deal Strategies, in Sustainable and Circular Management of Resources and Waste Towards a Green Deal*; Elsevier: Amsterdam, The Netherlands, 2023; pp. 49–63.
41. Ranta, V.; Aarikka-Stenroos, L.; Ritala, P.; Mäkinen, S.J. Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resour. Conserv. Recycl.* **2018**, *135*, 70–82. [CrossRef]
42. Liu, L.; Liang, Y.; Song, Q.; Li, J. A review of waste prevention through 3R under the concept of circular economy in China. *J. Mater. Cycles Waste Manag.* **2017**, *19*, 1314–1323. [CrossRef]
43. Liberati, A.; Altman, D.G.; Tetzlaff, J.; Mulrow, C.; Gøtzsche, P.C.; Ioannidis, J.P.; Clarke, M.; Devereaux, P.J.; Kleijnen, J.; Moher, D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care in-terventions: Explanation and elaboration. *J. Clin. Epidemiol.* **2009**, *62*, e1–e34. [PubMed]
44. 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.; et al. PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *BMJ* **2021**, *372*, n160. [CrossRef] [PubMed]

45. Paré, G.; Kitsiou, S. Methods for Literature Reviews. In *Handbook of eHealth Evaluation: An Evidence-Based Approach*; University of Victoria: Victoria, BC, Canada, 2017.
46. Joshi, C.; Seay, J.; Banadda, N. A perspective on a locally managed decentralized circular economy for waste plastic in developing countries. *Environ. Prog. Sustain. Energy* **2019**, *38*, 3–11. [CrossRef]
47. Ali, Y.; Jokhio, D.H.; Dojki, A.A.; Rehman, O.U.; Khan, F.; Salman, A. Adoption of circular economy for food waste management in the context of a developing country. *Waste Manag. Res.* **2022**, *40*, 676–684. [CrossRef]
48. Peiris, M.T.O.V.; Dayarathne, G.L.N. Application of Life Cycle Framework for Municipal Solid Waste Management: A Circular Economy Perspective from Developing Countries. *Circ. Econ. Sustain.* **2022**, *3*, 899–918. [CrossRef]
49. Debrah, J.K.; Teye, G.K.; Dinis, M.A.P. Barriers and Challenges to Waste Management Hindering the Circular Economy in Sub-Saharan Africa. *Urban Sci.* **2022**, *6*, 57. [CrossRef]
50. Oh, J.; Hettiarachchi, H. Collective Action in Waste Management: A Comparative Study of Recycling and Recovery Initiatives from Brazil, Indonesia, and Nigeria Using the Institutional Analysis and Development Framework. *Recycling* **2020**, *5*, 4. [CrossRef]
51. Oyelola, O.; Ajiboshin, I.; Okewole, J. Effective solid waste management in the circular economy: The case study of Lagos State, Nigeria. *Procedia Environ. Sci. Eng. Manag.* **2017**, *4*, 143–148.
52. Ezeudu, O.B.; Ezeudu, T.S.; Ugochukwu, U.C.; Agunwamba, J.C.; Oraelosi, T.C. Enablers and barriers to implementation of circular economy in solid waste valorization: The case of urban markets in Anambra, Southeast Nigeria. *Environ. Sustain. Indic.* **2021**, *12*, 100150. [CrossRef]
53. Tamasiga, P.; Miri, T.; Onyeaka, H.; Hart, A. Food Waste and Circular Economy: Challenges and Opportunities. *Sustainability* **2022**, *14*, 9896. [CrossRef]
54. Okafor, C.; Ajaero, C.; Madu, C.; Agomuo, K.; Abu, E. Implementation of circular economy principles in management of end-of-life tyres in a developing country (Nigeria). *AIMS Environ. Sci.* **2020**, *7*, 406–433. [CrossRef]
55. Ezeudu, O.B.; Ezeudu, T.S. Implementation of Circular Economy Principles in Industrial Solid Waste Management: Case Studies from a Developing Economy (Nigeria). *Recycling* **2019**, *4*, 42. [CrossRef]
56. Al-Salem, S.; Leeke, G.A.; El-Eskandarany, M.S.; Van Haute, M.; Constantinou, A.; Dewil, R.; Baeyens, J. On the implementation of the circular economy route for E-waste management: A critical review and an analysis for the case of the state of Kuwait. *J. Environ. Manag.* **2022**, *323*, 116181. [CrossRef]
57. Mihai, F.-C.; Gündoğdu, S.; Markley, L.A.; Olivelli, A.; Khan, F.R.; Gwinnett, C.; Gutberlet, J.; Reyna-Bensusan, N.; Llanquileo-Melgarejo, P.; Meidiana, C.; et al. Plastic Pollution, Waste Management Issues, and Circular Economy Opportunities in Rural Communities. *Sustainability* **2022**, *14*, 20. [CrossRef]
58. Ofori, D.; Mensah, A.O. Sustainable electronic waste management among households: A circular economy perspective from a developing economy. *Manag. Environ. Qual. Int. J.* **2022**, *33*, 64–85. [CrossRef]
59. Oyebode, O.J. Sustainable Waste Management towards Circular Economy in Nigerian Context: Challenges, Prospects and Way Forward. In *Advanced Manufacturing in Biological, Petroleum, and Nanotechnology Processing: Application Tools for Design, Operation, Cost Management, and Environmental Remediation*; Springer International Publishing: Cham, Switzerland, 2022; pp. 237–248. [CrossRef]
60. Wikurendra, E.A.; Ferto, I.; Nagy, I.; Nurika, G. Strengths, weaknesses, opportunities, and threats of waste management with circular economy principles in developing countries: A systematic review. *Environ. Qual. Manag.* **2022**, *32*, 87–94. [CrossRef]
61. Babayemi, J.O.; Ogundiran, M.B.; Osibanjo, O. Current Levels and Management of Solid Wastes in Nigeria. *Environ. Qual. Manag.* **2017**, *26*, 29–53. [CrossRef]
62. Paes, M.X.; de Medeiros, G.A.; Mancini, S.D.; Ribeiro, F.d.M.; de Oliveira, J.A.P. Transition to circular economy in Brazil A look at the municipal solid waste management in the state of Sao Paulo. *Manag. Decis.* **2019**, *59*, 1827–1840. [CrossRef]
63. Márquez, A.J.C.; Rutkowski, E.W. Waste management drivers towards a circular economy in the global south—The Colombian case. *Waste Manag.* **2020**, *110*, 53–65. [CrossRef]
64. Mokuolu, O.A.; Timothy, R.S. Circular Economy, and Waste Management Actions during the COVID-19 Pandemic in Nigeria. *J. Hum. Environ. Health Promot.* **2021**, *7*, 1–5. [CrossRef]
65. Amasuomo, E.; Baird, J. Solid waste management trends in Nigeria. *Br. J. Environ. Sci.* **2017**, *5*, 25–37. [CrossRef]
66. Salguero-Puerta, L.; Leyva-Díaz, J.C.; Cortés-García, F.J.; Molina-Moreno, V. Sustainability Indicators Concerning Waste Management for Implementation of the Circular Economy Model on the University of Lome (Togo) Campus. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2234. [CrossRef]
67. Wang, Y.; Shi, Y.; Zhou, J.; Zhao, J.; Maraseni, T.; Qian, G. Implementation effect of municipal solid waste mandatory sorting policy in Shanghai. *J. Environ. Manag.* **2021**, *298*, 113512. [CrossRef]
68. MacArthur, E. Towards the circular economy. *J. Ind. Ecol.* **2013**, *2*, 23–44.
69. Ikhlayel, M. Indicators for establishing and assessing waste management systems in developing countries: A holistic approach to sus-tainability and business opportunities. *Bus. Strategy Dev.* **2018**, *1*, 31–42. [CrossRef]
70. Shu, X.; Huang, B. Recycling of waste tire rubber in asphalt and portland cement concrete: An overview. *Constr. Build. Mater.* **2014**, *67*, 217–224. [CrossRef]
71. Aisien, F.; Hymore, F.; Ebewele, R. Application of Ground Scrap Tyre Rubbers in Asphalt Concrete Pavements. *Indian J. Eng. Mater. Sci.* **2006**, *13*, 333–338.
72. Agudelo, G.; Cifuentes, S.; Colorado, H.A. Ground tire rubber and bitumen with wax and its application in a real highway. *J. Clean. Prod.* **2019**, *228*, 1048–1061. [CrossRef]

73. Alfayez, S.A.; Suleiman, A.R.; Nehdi, M.L. Recycling Tire Rubber in Asphalt Pavements: State of the Art. *Sustainability* **2020**, *12*, 9076. [CrossRef]
74. Bimir, M.N. Revisiting e-waste management practices in selected African countries. *J. Air Waste Manag. Assoc.* **2020**, *70*, 659–669. [CrossRef]
75. Peluola, A. Investigation of the implementation and effectiveness of electronic waste management in Nigeria. *Model. Earth Syst. Environ.* **2016**, *2*, 100. [CrossRef]
76. Olukanni, D.O.; Aipoh, A.O.; Kalabo, I.H. Recycling and Reuse Technology: Waste to Wealth Initiative in a Private Tertiary Institution, Nigeria. *Recycling* **2018**, *3*, 44. [CrossRef]
77. Ugwu, C.O.; Ozoegwu, C.G.; Ozor, P.A. Solid waste quantification and characterization in university of Nigeria, Nsukka campus, and recommendations for sustainable management. *Heliyon* **2020**, *6*, e04255. [CrossRef] [PubMed]
78. Owamah, I.H.; Izinyon, O.C.; Igbinewekan, P. Characterization and quantification of solid waste generation in the Niger Delta Region of Nigeria: A case study of Ogbe-Ijoh community in Delta State. *J. Mater. Cycles Waste Manag.* **2017**, *19*, 366–373. [CrossRef]
79. Babatunde, B.B.; Vincent-Akpu, I.F.; Woke, G.N.; Atarhinyo, E.; Aharanwa, U.C.; Green, A.F.; Isaac-Joe, O. Comparative analysis of municipal solid waste (MSW) composition in three local government areas in Rivers State, Nigeria. *Afr. J. Environ. Sci. Technol.* **2013**, *7*, 874–881.
80. Wilson, D.C.; Velis, C.A.; Rodic, L. Integrated Sustainable Waste Management in Developing Countries. In *Proceedings of the Institution of Civil Engineers-Waste and Resource Management*; ICE Publishing; London, UK, 2013.
81. Cayzer, S.; Tuladhar, A. Drivers and Enablers Behind a Transition towards a Circular Economy: A Case Study of Nepal. In Proceedings of the International Association for Business and Society, Hong Kong, China, 6–10 June 2018.
82. Ezeudu, O.B.; Oraelosi, T.C.; Agunwamba, J.C.; Ugochukwu, U.C. Co-production in solid waste management: Analyses of emerging cases and implications for circular economy in Nigeria. *Environ. Sci. Pollut. Res.* **2021**, *28*, 52392–52404. [CrossRef] [PubMed]
83. Di Foggia, G.; Beccarello, M. Improving efficiency in the MSW collection and disposal service combining price cap and yardstick regulation: The Italian case. *Waste Manag.* **2018**, *79*, 223–231. [CrossRef]
84. Faisal, M.N.; Talib, F.; Bhutta, M.K. Enablers of sustainable municipal solid waste management system in India. *Int. J. Environ. Waste Manag.* **2019**, *23*, 213. [CrossRef]
85. Ezechi, E.H.; Nwabuko, C.G.; Enyinnaya, O.C.; Babington, C.J. Municipal solid waste management in Aba, Nigeria: Challenges and prospects. *Environ. Eng. Res.* **2017**, *22*, 231–236. [CrossRef]
86. Nzeadibe, T.C.; Ajaero, C.K. Development impact of advocacy initiatives in solid waste management in Nigeria. *Environ. Dev. Sustain.* **2011**, *13*, 163–177. [CrossRef]
87. Ezeah, C.; Roberts, C.L. Analysis of barriers and success factors affecting the adoption of sustainable management of municipal solid waste in Nigeria. *J. Environ. Manag.* **2012**, *103*, 9–14. [CrossRef] [PubMed]
88. Odoemene, U.D.; Ofodu, J. Solid wastes management in Aba Metropolis. *Int. J. Adv. Acad. Res.* **2016**, *2*, 1–7.
89. Yukalang, N.; Clarke, B.; Ross, K. Solid Waste Management Solutions for a Rapidly Urbanizing Area in Thailand: Recommendations Based on Stakeholder Input. *Int. J. Environ. Res. Public Health* **2018**, *15*, 1302. [CrossRef] [PubMed]
90. Nwosu, A.O.; Chukwueloka, H.E. A Review of Solid Waste Management Strategies in Nigeria. *J. Environ. Earth Sci.* **2020**, *10*, 132–143. [CrossRef]
91. Nkwachukwu, O.I.; Chidi, N.I.; Charles, K.O. Issues of roadside disposal habit of municipal solid waste, environmental impacts and implementation of sound management practices in developing country "Nigeria". *Int. J. Environ. Sci. Dev.* **2010**, *1*, 409–418. [CrossRef]
92. Rigasa, Y.A.; Badamasi, A.G.; Galadimawa, N.; Abubakar, G.U. Community based solid waste management strategy: A case study of Kaduna metropolis. *WIT Trans. Ecol. Environ.* **2017**, *210*, 761–772. [CrossRef]
93. Manual, T. *Developing Integrated Solid Waste Management Plan*; Prepared by United Nations Environ Program; United Nations Environment Programme: Osaka, Japan, 2009; p. 3.
94. Hoornweg, D.; Bhada-Tata, P. *What a Waste: A Global Review of Solid Waste Management*; World Bank: Washington, DC, USA, 2012.
95. Shooshtarian, S.; Maqsood, T.; Wong, P.; Khalfan, M.; Yang, R.; RMIT University. Review of energy recovery from construction and demolition waste in Australia. *J. Constr. Eng. Manag. Innov.* **2019**, *2*, 112–130. [CrossRef]
96. Agbesola, Y. Sustainability of Municipal Solid Waste Management in Nigeria: A Case Study of Lagos. Master's Thesis, Linköping University, Linköping, Sweden, 2013.
97. Ayuba, K.A.; Manaf, L.A.; Sabrina, A.H.; Azmin, S.W.N. Current Status of Municipal Solid Waste Management Practise in FCT Abuja. *Res. J. Environ. Earth Sci.* **2013**, *5*, 295–304. [CrossRef]