Achieving Sustainable Development by Integrating Circular Economy Principles into Solid Waste Management: A Systematic Literature Review and Research Agenda

Abstract

This study analyses the role of the circular economy (CE) and solid waste management (SWM) in addressing the Sustainable Development Goals (SDGs) and establishes links to address challenges such as environmental degradation, resource depletion, and social inequality. Uncontrolled waste impacts the social, environmental, and economic well-being of households, communities, and businesses worldwide. Yet, a comprehensive review of how the integration of the CE into SWM can address the SDGs is still missing.

This work is important for managers and policymakers alike in that it is a complete analysis of how SWM and CE models can be employed to address the entire spectrum of the 17 SDGs. To achieve this, a systematic review of 64 English-language peer-reviewed articles is conducted and the key roles of social, economic and environmental sustainability in SWM and the CE are discussed. This careful selection aligns with state-of-the-art review methods and includes the most relevant and recent studies to give a clear and trustworthy overview of the topic.

The finding shows that SDG 12 (sustainable consumption and production), SDG 13 (climate action) and SDG 11 (sustainable cities and communities) have received top priority, identifying that waste management directly relates to environmental sustainability and reduces the climate footprint in urban and rural contexts. Social concerns regarding equality and income were found to be less discussed but promising avenues, especially in the Global South, which faces great challenges in implementing the CE in SWM. Moreover, our results indicate the potential of the CE in SWM to combine the reduction of environmental and health burdens with the creation of income opportunities. To make these results tangible, a framework presents how the reviewed literature relates three groups of CE principles to five groups of SDGs. Moreover, a two-level research agenda outlines four research avenues on strengthening social considerations, technological innovation, policy, and developing countries, as well as two transversal research directions on using a wider set of CE practices and methods.

Keywords

Solid waste management, circular economy, SDGs, sustainable development goals, sustainable value creation, resource efficiency.

1. Introduction

Considering the global challenges of sustainability, poor waste management is still a burning societal, environmental and economic challenge (Debrah et al., 2021). In 2020, 0.76 kg of municipal waste were generated per capita per day – a figure that is projected to rise by almost 50% by 2050 if waste management is continued as usual (United Nations Environment Programme, 2024). Instead, the same scenario is projecting declining municipal waste generation of 0.62 kg per capita per day, i.e., a reduction of almost 20% by 2050, if the potentials of circularity are leveraged. This study therefore analyses the potential contribution of the circular economy (CE) in solid waste management (SWM) towards the attainment of the Sustainable Development Goals (SDGs).

Over the past three decades, research on the CE in SWM has developed immensely. From 1991 to 1999, environmental awareness was the focus of attention, followed by theoretical models and research on how companies would be shaped by sustainability (Sarkis, 1997). Concepts of waste management, life cycle analysis and green approaches to production were developed during these 10 years (Stuart et al., 1999). The period from 2000 to 2010 saw tighter environmental regulations, and corporations started to integrate CE methods into their operations. Closed-loop supply networks, recycling operations, takebacks for products and green inventory control models were the focus (Minner, 2001). Since 2011, digital technologies such as blockchain, the Internet of Things (IoT), artificial intelligence (AI) and big data have enabled novel approaches to CE implementation (Upadhyay et al., 2021). During this time, studies have further focused on standardising CE performance measurement and harmonising the CE with the SDGs (Goyal et al., 2021).

The CE has been developed to put structures in place that allow for the reuse and recycling of materials in the design and construction of their life cycles, thereby reducing waste and cyclically increasing resource efficiency (Benachio et al., 2020). Therefore, the CE is considered a means of accelerating the achievement of the SDGs and a paradigm shift in tackling the challenges of SWM (Khatiwada et al., 2021). The importance of the CE in sustainable waste management regarding recycling, reuse and waste reduction has recently been emphasised (Da Sliva et al., 2022). Since attaining the SDGs requires the decoupling of environmental performance from economic activity, circular and bio-based approaches have been proposed to enhance environmental performance and enable more efficient use of natural resources (Ferraz and Pyka, 2023). The CE has also been used as an alternative to the conventional linear economic model, focusing on waste minimisation, resource recovery and material optimisation (Mandpe et al., 2022). In plastic waste management, strategies have explored the need for effective policies, advanced technology and social participation (Ramli et al., 2024). A review targeting global and regional SWM challenges discussed ways to reduce waste, improve SWM infrastructure and increase public awareness about the negative effects of waste disposal practices (Awino et al., 2024).

From the above, it is evident that the CE evolved from a theoretical construct in the 1990s to a technology-enabled operating model in the 2020s (Vann Yaroson et al., 2024). Still, comprehensive analyses of the SDGs' interlinkages with the CE are limited. Beyond the prevalent focus on the CE from the perspective of industrial strategy and policymaking, theoretical foundations are required that encompass driving factors, hindrances, digital instruments and fruitful research avenues for aligning the CE and SWM for sustainability.

Therefore, we formulated the following research questions (RQs) for our study:

RQ 1) How does the integration of the CE and SWM contribute to achieving the SDGs?

RQ 2) What are the current gaps in research on integrating SWM and the CE to achieve the SDGs, and what future research avenues can address them?

To answer the RQs, we conduct a systematic literature review (SLR) in line with the latest guidelines (Sauer and Seuring, 2023; Seuring et al., 2021), reviewing 64 English articles obtained through a structured process. The objective of this SLR is to extract and critically reflect on the existing body of literature by presenting what we know and what we do not know about the intersection of the CE and SWM and the impact of the CE and SWM on the SDGs. In this way, we aim to close the gaps in the present knowledge of this specific topic and make a significant move forward by making three key contributions.

First, we systematically review how the literature on the CE in SWM discusses their contribution to the SDGs, answering RQ1. To enable this, in Section 2, we provide groupings for the 10R CE principles (e.g., Bag et al., 2021) and the SDGs and mobilise them in our synthesis of the literature in Section 4. The results support the traditional focus of the SWM literature on the environmental aspects of the SDGs (Govindan et al., 2020). Moving beyond this, we find in the literature support for emerging discussions on the social impact of SWM, especially in developing economies, in terms of reducing inequalities, giving access to safer working and living conditions and creating opportunities for economic growth and innovation.

Second, we dive deeper into the contribution of the CE in SWM to the SDGs by reviewing which CE principles are linked to which groups of SDGs, answering RQs 1 and 2. This synthesis, in Section 4.3, shows the traditional strongholds of the CE in the SGDs. This encompasses the link of reuse, repair and remanufacturing to responsible consumption (SDG 11) and the link of recycling and recovery to climate action (SDG 13). Beyond this, our findings call for researchers and practitioners to leverage the potential of the CE in SWM to reduce inequality by extending the life of products and their parts (e.g., SDG 1) or creating sustainable growth opportunities (SDG 8).

Third, in Section 5, we propose a two-dimensional research agenda that combines two transversal research directions with four research areas and answers RQ2. This combination is proposed to close the gaps in the current literature and leverage the potential of the CE in SWM to address today's grand challenges in terms of the climate crisis and globalisation of waste streams, such as in developing economies, as well as mobilising technological advances for this.

In structuring the study and its contributions, we align with Seuring et al.'s (2021) guidelines on comprehensively applying theory in SLRs by first outlining a clear structure for our analysis in Section 2 and then using this structure to develop a framework for the contribution of the CE in SWM to the SDGs in Section 4.3 and Figure 5, before guiding future research based on a research agenda outlined in Section 5.

2. Theoretical background and scope formulation

In this section, we clarify the theoretical background and theoretical scope of the SLR. For achieving this, we first introduce the context of SWM and the CE in Section 2.1 and five sub-sections that clarify the two concepts step by step. Second, Section 2.2 outlines how SWM and the CE can contribute to achieving the UN SDGs.

2.1. The context of SWM and the CE

2.1.1. Impacts of Improper Waste Disposal

Waste has several economic, environmental, social and health impacts if not disposed of properly. Improper disposal of waste creates soil, air and water pollution and ecosystem degradation and adds toxic compound burdens to the food chain (Singh, 2019). Waste produces harmful chemicals and gases that are related to cancer, birth defects, brain damage and respiratory diseases. Studies by Dehghani et al. (2021), Johnson (2020), and Mihai et al. (2021) show that ineffective solid waste management (SWM) not only poses health risks such as increased respiratory diseases, congenital disabilities, and psychological damage, especially for populations near landfills or incinerators, but also creates economic burdens by requiring cleanup of polluted sites, reducing property values, and affecting tourism and agricultural productivity. Instead, improving agricultural productivity boosts the income of rural communities, which in turn leads to a gradual decline in poverty levels in those areas (Ullah et al., 2024). Furthermore, waste combustion can cause long-term health problems through air pollution and leachate infiltration into water supplies. To counter this, there is consensus that SWM can effectively reduce the impact of waste on our health (Vinti et al., 2021).

2.1.2. Role of Solid Waste Management (SWM)

Beyond direct health risks, effective waste management also depends on efficient resource recovery and active citizen engagement. Recycling and resource recovery through SWM contribute to the financial sustainability of the water industry by reducing costs. In addition, citizens' engagement through financial incentives helps enhance the efficiency of waste management systems (Lakiotia, 2017). Proper SWM improves living standards, reduces discrimination towards waste pickers and improves public health by lessening the impact of environmental pollution. This last process helps reduce poverty by generating employment income for the poor (Marello, 2018).

To enable this, the discipline of waste management aims to structure waste streams in such a way that reusable waste is reintegrated into the production cycle, thereby requiring collaboration between manufacturing companies and recycling systems (Zerbino et al., 2021). In effect, SWM systems have been found to mitigate health and environmental problems and to promote sustainable development at large (Al-Dailami et al., 2022). SWM is critical to environmental management and includes a variety of processes involving waste collection, segregation, transportation, treatment and disposal aimed at minimising environmental harm and maximising resource use. This emphasises the role of SWM in addressing the problems of waste generation arising from urbanisation, industrialisation and the constant growth of the global population. Turning to the climate crisis, effective SWM reduces pollution and decreases methane and CO_2 emissions (Das et al., 2019).

2.1.3. Contribution of Circular Economy (CE)

CE can complement SWM by targeting the elimination of waste and pollution through the recycling of resources, thus improving environmental, economic and social outcomes (Korhonen et al., 2017). This is done throughout the life cycle of materials, from extraction and industrial processing to consumer use. The aim is to recharge industrial systems with secondary resources or to facilitate the safe return of materials to the environment through the natural regeneration cycle (Geissdoerfer et al., 2018). The systemic application of the CE creates value at both the macro and micro levels, while the long-term success of the CE depends on the role that governments and conscientious consumers play (Nobre and Tavares, 2021).

Even though the CE may be costly, recent studies have shown that its implementation increases profitability by saving raw materials and energy, thus increasing the efficiency and financial performance of firms implementing the CE (Dey et al., 2022). The latest studies have integrated CE principles into SWM to address the challenges of waste reduction, resource efficiency and attaining long-term socioeconomic and environmental benefits (Sharma et al., 2021). SWM is subjected to the CE due to the latter's superiority in several measures, such as reducing landfill utilisation, reusing resources, creating economic value, mitigating environmental pollution and promoting social and economic sustainability (Rathore and Sarmah, 2020). The CE reduces dependency on fossil fuels by generating energy, such as biogas, from waste and by generating valuable secondary resources. Moreover, it minimises environmental costs, as reflected in reduced greenhouse gas emissions and improvements in waste management practices (Rashid and Shahzad, 2021). Nevertheless, structural changes in waste management can entail short-term costs, which are socially challenging to accept but contribute in the long term to social and economic sustainability (Tomić and Schneider, 2020).

Summarizing the contribution of the CE to sustainable development, it is grounded in enabling the move from waste-, and energy-intensive linear production and consumption systems towards increased reutilization of resources, parts and entire products. This move was initially focused on reducing environmental pollution and resource consumption. Recently, the CE was increasingly understood to be also a driver of social and economic progress by reducing the cost to access certain products and enabling a longer productive product live (De Lima et al., 2021).

2.1.4. Barriers to Circular Economy (CE) Adoption

The main barriers to implementing the CE include financial constraints, inadequate infrastructure, a lack of government support, global market inconsistencies, the high cost of sustainable materials and low profit margins, which make CE adoption challenging (Wang et al., 2022). Additionally, the lack of knowledge sharing among organisational departments, failure to reuse past project experiences and weak documentation of tacit knowledge have led to reduced efficiency and increased waste (Debrah et al., 2021). Moreover, the lack of coordination between product design and material sourcing, inadequate planning for sustainable production and weaknesses in information systems for managing environmental data are other key barriers to implementing CE principles (Nujen et al., 2023).

2.1.5. Introduction of the 10Rs Framework

As presented in Figure 1, the 10Rs framework (Reike et al., 2018), as structured in this article, is a comprehensive model for sustainable waste management categorised into three main sections: (1) intelligent product use and production, encompassing reject (R0), rethink (R1) and reduce (R2); (2) extension of the useful life of products and their parts, covering reuse (R3), repair (R4), recondition (R5) and remanufacture (R6); and (3) useful application of materials, involving recycle (R8) and recover (R9). This framework is designed to align with circular economic principles, but at the same time, it enables the understanding of three key stages in the product life cycle that can be leveraged to gain a finer-grained understanding of the contribution of the CE to the SDGs.

[Insert Figure 1 here]

The structuring of the 10Rs into three sections presented in Figure 1 also serves the preparation of the analysis of the reviewed literature, as presented in more detail in Section 3. For this analysis, the CE with its 10Rs is the first part, while the SDGs are the second part that are presented next and again grouped into a framework in Figure 2.

2.2. Roles of the CE and SWM in achieving the SDGs

The previous section discussed the roles of SWM and the CE in enhancing management practices and reducing environmental, social, economic and health impacts. This section analyses the relationships between these two concepts and the SDGs, providing a broader context within which the SDGs interact with SWM and the CE. In 2015, the system of eight Millennium Development Goals (MDGs) came to an end with the acknowledgement of the global community's realisation that a new system should be established to enable true sustainable development. The 17 SDGs were therefore introduced in September 2015 as a more inclusive replacement of the MDGs (Pedersen, 2018) in a quest to strike a balance between economic progression, social equality and environmental sustainability (Bexell and Jönsson, 2017). Figure 2 presents the SDGs by grouping them into five thematic categories based on their primary focus areas. This categorisation helps in understanding how different sustainability aspects are interconnected and align with the CE and SWM.

Contrasting with the MDGs' emphasis on social and economic aspects, the SDGs actualise sustainable development as a holistic system that integrates environmental aspects (Pedersen, 2018). The SDGs are intended to guide countries on how to balance economic, social and environmental aspects. Moreover, they provide practical targets and actions addressing the critical global challenges of poverty, climate change, inequality and ecological degradation (Assembly, 2015).

The multifaceted relationships between waste management and the SDGs are evident; however, waste management is implicitly embedded in multiple other SDGs (Lerpiniere et al., 2024). Recycling and the CE principles emphasising waste reduction and resource efficiency are the critical elements that foster environmental sustainability, minimise greenhouse gas (GHG) emissions and improve resource efficiency (Iqbal et al., 2023). Likewise, the integration of waste-to-energy and innovative recycling systems into

SWM has improved the prospects for sustainable development in developing countries (Ferronato et al., 2022).

Embedding CE principles into SWM frameworks has proven to be highly effective. During the pandemic, the CE coupled with SWM reduced waste generation, decreased environmental impacts and improved supply chain resiliency through recycling and resource reuse. These efforts have directly assisted in reaching key SDGs, as circular resource flows and a decreasing dependence on linear production systems have been promoted (Sharma et al., 2021). CE-based waste management models have shown great promise in specific sectors, such as universities and hospitals. SWM and the CE, as key drivers of sustainable development, are linked to environmental sustainability, resource efficiency and innovative practices (Ranjbari et al., 2023). In addition, they play an instrumental role in attaining global sustainability through progress towards sustainable and resilient development (Soni et al., 2022). Despite these benefits, challenges exist in developing the CE and SWM into full-fledged SDG programs. Barriers such as a lack of financial resources, insufficient staff expertise and ongoing adherence to traditional approaches have prevented the full realisation of the CE and SWM's capacity to advance the SDGs and led to a call for further research at this intersection (Shabani et al., 2024), which we aim to provide through an SLR, as explained next.

[Insert Figure 2 here]

3. Methodology

An SLR is recognised as a reliable approach for systematically searching, evaluating and interpreting a field of scientific research (Sauer and Seuring, 2013). Following best practices, we applied the PRISMA framework (Moher et al., 2016), which maintains enhanced transparency and reliability at all review stages, from identification to screening, eligibility decisions and data analysis. PRISMA-based SLRs provide a systematic study of research findings, reduce bias and are highly effective in achieving research objectives (Sauer and Seuring, 2023).

To ensure a comprehensive review of all relevant papers from prior studies, as well as the quality of the study, the SLR process should be structured into key stages (Sauer and Seuring, 2023). Accordingly, this study assessed four phases: (1) identification, (2) screening, (3) eligibility and (4) data analysis and literature synthesis. These four phases are illustrated in Figure 3, along with details applied in this study. For these details, we followed key guidelines for avoiding biases in the SLR process, ensuring transparency using PRISMA (Moher et al., 2016) and structuring the authors' work and presentation of the results in a reproducible way (Sauer and Seuring, 2023). Figure 3 presents the detailed PRISMA-based article selection flowchart.

As presented in Figure 3, the initial identification phase involved a search on the Scopus database using key terms relevant to "solid waste management" AND "circular economy". Restrictions were applied to the search, limiting it to scientific articles written in English with unlimited publication period, and 1725 articles were identified. The Scopus database was chosen due to its broad coverage of more than 48,000 sources, of which more than 44,000 were journals by the time of data collection. This fits the purpose of our SLR and makes Scopus one of the top databases for SLRs in production and operations management disciplines (see also Sauer and Seuring, 2023).

To ensure relevance, the titles, keywords and abstracts of all 1725 articles were reviewed. After reviewing titles, keywords, and abstracts, 1630 articles unrelated to the SDGs were excluded, leaving 95 for further evaluation. These were reviewed in full to ensure coverage of the most critical subjects of the CE and SWM related to the SDGs. Through this process of careful and selective reading, the number of articles was reduced to 50 based on relevance. This selection process was systematic, transparent and organised, following the PRISMA framework. It was explicitly designed to select only articles specifically addressing the SDGs for the final analysis. Moreover, to check whether the reviewed body of literature referenced more studies relevant to our research question, the snowballing method was also applied (Dieste et al., 2022). Through backward and forward snowballing, 14 additional studies were included in the final sample. This method allows for the identification of a greater number of relevant studies. A hybrid search strategy that integrates systematic database searches with backward and forward snowballing has been shown to enhance the quality and scope of an SLR, providing more comprehensive coverage of academic sources. This approach helps reduce potential biases and fills potential gaps in the article selection process, enabling the identification of key research beyond the initial database queries (Wohlin et al., 2022). As a result, 14 studies were added to the final sample. Although we did not impose a time boundary during the search, 64 articles dating from 2019 onwards were included in the sample. However, this made sense because the United Nations officially adopted the SDGs in September 2015.

In the data abstraction phase, the 64 selected articles were qualitatively analysed using a content analysis method (Mayring, 2010) by adopting a deductive approach that allows for the refinement of theories in an SLR (Seuring et al., 2021). Section 2 presents these deductive elements, which are the theoretical concepts of SWM, the CE and the SDGs and their interrelationship. Following Seuring et al. (2021) and Sauer and Seuring (2023), we used these concepts to map the literature within single concepts in Section 4 to answer RQ1. Section 5 critically investigates the relationships between the concepts to answer RQ2. Following Sauer and Seuring (2023), different aspects of the SLR need to be documented – namely, (1) the search process (Figure 3), (2) the deductive coding schemes (Figures 1 and 2), (3) the final review sample (Table B.1 of Appendix B), (4) the review outcome (Figure 5), and (5) the research agenda (Figure 6).

The structured approach used in this study drives objectivity throughout the research process (Seuring & Gold, 2012). To increase the reliability of the content analysis, the first author independently analysed and coded the reviewed papers. This process was supported by multiple rounds of discussions with the second researcher, who supervised the work, provided critical feedback and facilitated resolving disagreements or complexities related to coding the SDGs and the CE principles. All codings were thoroughly reviewed and refined until consensus was reached between the authors. This approach, which has been used to ensure inter-coder reliability in SLRs in the field of operations management (Seuring & Gold, 2012), was critical to the integrity of the study. A third researcher, who did not participate in the coding process, was brought in as an external reviewer for this process. This individual, acting as a devil's advocate, provided a more objective perspective on developing the framework and on final discussions with differing views on coding unclear text passages. Further revisions were made based on their feedback until consensus was reached (Dieste et al., 2022).

[Insert Figure 3 here]

4. Findings

4.1. Descriptive findings

The review on SWM and the CE covered the period from 2019 to 2025 and showed the growing importance of environmentally sound waste management, with the highest number of papers covering this topic from the years 2022 (n = 18), 2023 (n = 15) and 2024 (n = 13), compared to two papers in 2019 and five in 2020. The sample spanned high-impact-factor journals, such as *International Journal of Production Economics*, *Science of the Total Environment*, *Journal of Environmental Management*, *Waste Management & Research*, *Journal of Cleaner Production*, *Circular Economy and Sustainability* and *Resources, Conservation & Recycling*. The studies covered various approaches, such as SLRs (n = 14), literature reviews (n = 10), survey-based methods (n = 10), bibliometric analyses (n = 7), interviews (n = 5), case studies (n = 4), statistical analyses (n = 2), life cycle assessments (n = 2), empirical analyses (n = 1) and others (n = 10).

4.2. Thematic findings

The thematic findings are systematically organised below to contribute to answering RQ1 on how the integration of the CE and SWM enable to achieving the SDGs. The reviewed papers were analysed based on each SDG, drawing on the insights presented while also highlighting emerging perspectives. Figure 4 summarises the overall coding results according to how many papers investigated the contribution of the CE and SWM to single SDGs. These results show an uneven distribution of focus in the literature on single SDG groups, which, to some extent, is due to the nature of SWM and the CE as concepts with a traditionally strong link to environmental sustainability. However, beyond this tradition, we could identify further contributions to the SDGs, which we present below, structured according to the SDG groups introduced in Figure 2.

[Insert Figure 4 here]

4.2.1. SDG Group 1: Social well-being and equity

The first SDG group encompasses five SDGs, and only 13 instances (i.e. a paper coded for one specific SDG, since one paper could be coded for multiple SDGs) are evident in the reviewed literature in which this group is discussed. This is an interesting outcome because it underlines that there is an emerging discourse on the impact of the CE in SWM on social well-being and equity, but at the same time, we need to underline that this SDG group is largely outside the focus of the reviewed studies. The emerging discussions we found for single SDGs are presented below.

First, SWM and CE practices can achieve **SDG 1 (no poverty)**. Practices in SWM, such as waste valorisation, create new business opportunities and improve the livelihoods of vulnerable populations, thereby supporting poverty alleviation (Kadhila et al., 2023). For instance, the CE can help create green jobs (e.g. recycling, remanufacturing, repair and maintenance) and provide new employment opportunities for poor and economically vulnerable groups, thereby reducing poverty (Morais et al., 2022). The introduction of CE practices, such as the 5R model, enables waste pickers to engage in meaningful work and contributes to poverty reduction (Eelshekh et al., 2021). Moreover, reducing construction costs reduces the need for external resources and leads to increased self-sufficiency in communities, which has a direct impact on poverty reduction (Shehata et al., 2022). Additionally, SWM, as an essential service for waste collection and recycling, can help improve public health and access to basic services for poor communities (Whiteman et al., 2021).

Second, using CE practices such as waste-derived compost will help achieve **SDG 2 (zero hunger)** by recycling agricultural waste under CE principles, thereby significantly increasing food security (Craparo et al., 2023). Furthermore, the 6R framework for food waste reduction can alleviate hunger by effectively repurposing resources (Almulhim, 2024). Reusing waste in the production of building materials reduces the need to extract raw materials, which indirectly helps protect agricultural land for food production, thereby reducing hunger and increasing food security (Elsheekh et al., 2021).

Third, CE-focused educational initiatives support to **SDG 4 (quality education)** by enhancing awareness of sustainable waste management, promoting greater community participation, increasing educational outreach, promoting the integration of sustainability and encouraging the adoption of sustainable practices (Shabani et al., 2023a; Owojori et al., 2020).

Fourth, CE initiatives reveal the relationship between implementing **SDG 5 (gender equality)** by creating job opportunities for women and preventing gender inequality. Through these initiatives, women gain access to economic opportunities within sustainable waste management, thereby empowering them and supporting broader social equity (Morais et al., 2022).

Finally, **SDG 10 (reduced inequalities)** belongs to this first group but was not discussed in the reviewed literature. Nevertheless, we want to challenge researchers to investigate the relationship between SDG 10 and the environment, such as through the concept of environmental justice, which includes three key dimensions: ensuring equal access to natural resources, such as water and land; recognising the rights and roles of marginalised communities in environmental policies; and ensuring their participation in decision-making processes (Kuhn, 2020). Furthermore, disadvantaged populations are more vulnerable to the impacts of climate change, such as floods and droughts. Therefore, reducing inequalities through SDG 10 interrelates with environmental sustainability and ensures that all segments of society, especially the most vulnerable, can participate in and benefit from environmental resource management and related policies (Apel, 2020).

Despite the promising contributions of CE practices to social well-being, several key challenges remain for realizing SDG group 1. There is little investment and institutional encouragement for green job generation among vulnerable groups, which restricts broader social inclusion. Additionally, there remains inadequate infrastructure for agricultural waste recycling that continues to hamper the scalability of CE practices in food systems (Leal Filho et al., 2021). Educational efforts on CE also have limitations, particularly in marginalized or low-resource settings, where access and outreach are still insufficient (Zickafoose et al., 2024). These challenges currently restrict the potential of CE in SWM to create social well-being and equity, but beyond this, inequality can also be driven by the lack of access to safe working and living conditions, the findings on which are discussed next.

4.2.2. SDG Group 2: Access to safe conditions

SDG group 2 encompasses three SDGs, and 48 instances were evident in which the reviewed papers discussed a contribution to these SDGs. As a result, this group ranked third in the number of instances, which is a positive signal because the mentioned safe conditions are key to reducing the negative impact of SWM on our societies, especially the people involved in formal and informal SWM operations.

The integration of CE principles alongside SWM is crucial for achieving **SDG 3 (good health and well-being)**. This is particularly important for addressing the risks of waste spills, which often occur in areas with weak or non-existent environmental law enforcement, and highlights the link between waste mismanagement, health risks and poor ecological governance (Ram and Bracci, 2024). Urban waste, particularly in high-density urban areas, leads to environmental pollution, the spread of waste-related diseases and public health threats, emphasising the importance of improving waste management systems to enhance public health and well-being (Voukkali et al., 2024; Wright et al., 2019). The mismanagement of plastic waste leads to environmental pollution, which poses severe health risks, such as respiratory diseases and waterborne infections, emphasising the need for improved SWM strategies (Kadhila et al., 2023). Similarly, waste separation, recycling and reuse were identified as key measures for enhancing the health and well-being of people living in their respective communities (Lerpiniere et al., 2024).

Furthermore, the CE and SWM help achieve to SDG 3 by reducing pollution, minimising landfill dependency and promoting public health (Kumar et al., 2021). CE strategies, including the reduction of waste and the reuse of resources, can also indirectly promote public health and social well-being by reducing pollution (Fiksel et al., 2022). For instance, geopolymer concrete lead to health outcomes by reducing environmental and hazardous waste exposure (Shehata et al., 2022). Developing medical waste management systems reduces the transmission of diseases and supports the proper management of medical waste through incineration or disinfection (Elsheekh et al., 2021; Ranjbari et al., 2023). Moreover, these benefits can be amplified through IoT-based waste management systems (Fatimah et al., 2020; Sharma et al., 2021).

Recycling wastewater in industry, agriculture and other water uses is regarded as a CE practice associated with **SDG 6 (clean water and sanitation)** (Issaoui et al., 2022), which was discussed by more than a third of the reviewed papers. Increasing municipal waste generation and illegal landfilling are major challenges causing soil and water resources to deteriorate and requiring a shift to CE models (Oliveira et al., 2023). The transition from a linear model to a circular model can reduce waste and extend waste reuse, thereby improving water quality (Ye et al., 2023; Zhou et al., 2022). Moreover, incorporating CE principles will improve water quality and decrease water pollution (Ram and Bracci, 2024; Shabani et al., 2023b; Mandpe et al., 2022). Advanced waste technologies, such as the IoT, help minimise the contamination of clean water (Fatimah et al., 2020). Water pollution caused by poor waste management, such as the leaching of harmful substances into water systems (Sharma et al., 2021), can affect public health, and creating appropriate infrastructure for waste collection and disposal can help improve water quality and reduce pollution (Lerpiniere et al., 2024; Giri et al., 2024). Implementing source-separated collection of plastic waste helps eliminate dumping and prevent the pollution of water resources, thereby preserving water quality (Ferronato et al., 2024).

Energy technologies contribute to **SDG 7 (affordable and clean energy)** by providing renewable energy from waste materials (Panchal et al., 2021). Additionally, the CE serves to promote energy efficiency and production, waste reduction approaches and clean energy practices (Kadhila and de Wit, 2022; Ye et al., 2023). Waste-to-energy sources of renewable energy generation, such as biogas and biofuel, receive substantial support from SWM processes, fostering renewable energy generation (Kumar et al., 2021). By utilising recycled materials instead of fossil fuels, the CE reduces dependency on non-renewable resources, as evidenced by the transformation of agricultural waste into bioenergy (Rani et al., 2023; Voukkali et al., 2024). SWM can reduce energy consumption in the production of new raw materials, and the recycling of materials such as metals, plastics and paper requires much less energy than the production of virgin materials (Abad Segura et al., 2020; Shehata et al., 2022).

Despite growing emphasis being placed on health, water, and energy-focused SDGs within CE–SWM literature, several challenges persist. First and foremost, weak environmental law enforcement and poor governance continue to exacerbate the health risks of unchecked waste, most specifically in cities. Second, ineffective facilities for medical and toxic waste disposal limit the optimal control of disease as well as safeguarding the health of the public (Evaristo et al., 2023). Both challenges underline the critical role of a suitable governance controlling the SWM operations.

In summary, SDG group two underlines the importance of access to save conditions that can also be seen as an antecedent to sustainable growth for which we present the findings in the next section.

4.2.3. SDG Group 3: Sustainable growth and governance

SDG group three encompasses three SDGs, and 26 instances were evident in which the reviewed literature discussed contributions to the SDGs. This indicates that, although contributions to these SDGs are present, they are not the primary focus of the reviewed literature, but we want to underline the value of the CE in SWM to enable growth and innovation opportunities that can also support the other SDG groups.

The CE and SWM play a transformative role in attaining **SDG 8 (decent work and economic growth)** by creating employment opportunities and fostering economic growth (Elsheekh et al., 2021). By formalising the informal waste sector, CE strategies enhance working conditions and enable economic participation for marginalised workers (Kadhila et al., 2023). The CE and SWM also lead to economic growth by supporting start-ups and small-business development focused on recycling and innovative technologies (Kumar et al., 2021). Similarly, CE practices enhance local employment, reduce poverty and improve livelihoods through creative waste management that boosts economic sustainability (Kadhila and de Wit, 2022; Iqbal et al., 2023; Voss et al., 2023). For instance, integrating informal labour into formal waste management increases economic productivity and strengthens the social and economic performance of low-income groups, thereby contributing to inclusive economic growth (Fatimah et al., 2020; Mandpe et al., 2022). In line with this, CE-based practices and innovations contribute to economic benefits, including industrial growth and job creation (Abad Segura et al., 2020; Shehata et al., 2022; Sharma et al., 2021). Similarly, the introduction of a waste management system is an innovation that leads to sustainable economic growth and sustainable employment (Panchal et al., 2021; Shabani et al., 2023a).

Innovations in SWM systems will be critical to the achievement of **SDG 9 (industry, innovation and infrastructure)** by addressing the development of sustainable and efficient infrastructures. For instance, waste sorting and collection processes can be improved based on innovative technologies, such as AI and IoT, which improve the efficiency of CE materials collection and transportation to suitable recycling infrastructure (Kumar et al., 2021; Maalouf and Agamuthu, 2023). Achieving SDG 9 should include the advancement of infrastructure to support sustainable practices (Kurniawan et al., 2022), such as Industry 4.0 technologies that can enhance recycling and material reuse, positively impacting sustainable industrial infrastructure and waste recycling within the CE framework (Bai et al., 2020). The CE accelerates innovation by driving the creation of supportive, sustainable industries and infrastructure through advanced waste recycling technologies (Abad Segura et al., 2020; Panchal et al., 2021).

Despite the positive effects of CE and SWM on industrial innovation and economic development, several impediments hinder a more complete realization of SDG 8 and 9. Start-ups and small-scale recycling enterprises often lack access to financial resources and technology in most developing countries. Moreover, high-tech waste management technologies face underdeveloped infrastructures for their accommodation, particularly in rural and low-income urban areas. Finally, data-driven innovations such as AI and IoT require human and digital capital that are normally in short supply (Govindan, 2022).

Building on the mentioned infrastructures, new partnerships may be developed, as discussed next.

4.2.4. SDG Group 4: Sustainable partnerships

SDG group four encompasses three SDGs, but with 110 instances in which the reviewed papers discussed contributions to the SDGs, this group is clearly central to discussions in the field and encompasses the following key points.

Managing waste through separation, recycling and reuse directly supports **SDG 11 (sustainable cities and communities)** by improving urban waste management systems and encouraging sustainable waste collection practices. Public awareness campaigns regarding waste management also play a crucial role in urban areas, educate communities, promote safer collection systems and reduce pollution in cities (Ferronato et al., 2024).

Guided by CE principles, these efforts strengthen SDG 11 via enhanced urban infrastructure and make cities more sustainable (Owojori et al., 2020; Paes et al., 2024; Mariyam et al., 2024; Zhou et al., 2022). SWM practices, when guided by CE principles, also contribute by reducing resource use through recycling and reuse, which are essential for sustainable development (Kurniawan et al., 2022; Elsheekh et al., 2021).

Moreover, urbanisation is key in SDG 11 and significantly impacts waste generation and greenhouse gas emissions, limiting urban growth by increasing landfill dependency and waste production (Mandpe et al., 2022; Morais et al., 2022; Soni et al., 2022). However, adopting CE practices effectively mitigates these environmental challenges and fosters healthier and more sustainable urban environments (Magazzino et al., 2022).

Within urbanization, innovative tools, such as the IoT, and eco-friendly practices, such as recycling and reprocessing plastics, improve urban waste management and help achieve sustainable urban development (Zyoud and Zyoud, 2024; Ya et al., 2023; Ejaswini et al., 2022; Shehata et al., 2022). Effective SWM is highly influenced by CE and environmental policies, with higher-income cities achieving higher rates of controlled disposal and recycling than low-income cities (Velis et al., 2023).

As a result, CE practices in SWM, including waste reduction, recycling and resource reuse, lower greenhouse gas emissions, enhance urban environmental sustainability and promote healthier living conditions (Fiksel et al., 2022; Ferronato et al., 2022; Kadhila et al., 2023) in urban and rural areas (Mihai et al., 2021).

SDG 12 (responsible consumption and production) is the key SDG in the review and was discussed in all but three papers. The CE in SWM can foster SDG 12 through the development of sustainable consumption and production patterns based on waste separation, resource recovery and relieving pressure on natural resources and performs better than conventional disposal methods (Mariyam et al., 2024; Paes et al., 2024; Magazzino et al., 2022). Separation programs and collection services are key in sustainable resource management, reducing waste generation and increasing recycling rates (Valenzuela-Levi, 2019; Kumar et al., 2021; Oliveira et al., 2023; Whiteman et al., 2021; Kurniawan et al., 2022). Moreover, innovative methods, such as substituting natural resources (e.g., sand) with secondary materials and using the IoT to improve waste collection, separation and recycling, enhance resource management and conservation, replacing linear consumption models to promote sustainability (Poranek et al., 2022; Zyoud and Zyoud, 2024; Govindan et al., 2023; Ye et al., 2023; Kadhila et al., 2023; D'Adamo et al., 2024).

SDG 12 can benefit from incorporating CE principles and policies that can reduce resource wastage, improve production practices and promote environmental benefits through resource reuse and waste avoidance (Abad-Segura et al., 2020; Shabani et al., 2023a; Craparo et al., 2023; Govindan et al., 2020). The 6R and 10R frameworks are effective for reducing material waste and enhancing resource efficiency (Almulhim, 2024; Do et al., 2021; Sharma et al., 2021). Plastic recycling plays a key role in achieving SDG 12 (Tejaswini et al., 2022a). The CE and SWM reduce landfill dependency, increase recycling rates and promote sustainability by minimising plastic use and enhancing CE models (Mihai et al., 2021; Ferronato et al., 2024; Tejaswini et al., 2022b; Singh, 2022).

The mentioned contributions to SDG 12 can be supported by environmental commitments, social pressure and green economic incentives, thereby improving sustainable supply chain management (Centobelli et al., 2021). Achieving this SDG requires coordinated policies, investment in education and standardised data (He et al., 2022).

SDG17 (partnerships for the goals) is achieved through collaboration between governments, the private sector and communities for the successful implementation of SWM and the CE. SDG 17 promotes cooperation and resource sharing between stakeholders to facilitate the integration of the CE and SWM, thus promoting sustainable development on the largest scale (Paes et al., 2024; Lerpiniere et al., 2024). Moreover, joint investments between developed and developing countries can help develop waste management infrastructure and more sustainably manage today's globalised waste stream (Wright et al., 2019). For example, international collaborations like the Global Partnership on Waste Management have promoted knowledge exchange and joint investment projects that help improve waste infrastructure, especially in developing countries (UNEP, 2021). In India, public-private partnerships (PPPs) have been promoted to address structural issues and enhance infrastructure; however, governance challenges and the lack of an enabling environment often hinder their effectiveness (Agarwal et al., 2023). A successful case is the Swachh Bharat Mission (Urban) in India, which consolidated PPTs, citizen participation, and government cooperation to improve municipal waste infrastructure (Ministry of Housing and Urban Affairs, 2023).

However, some key challenges, such as governance issues, lack of transparent funding mechanisms, and misaligned stakeholder priorities, often impede partnership effectiveness (Griggs et al., 2017). First, rapid urbanization overwhelms waste infrastructure in the majority of cities (Gelan and Girma, 2022). Second, resistance from consumers to circularity practices and lack of awareness inhibit sustainable consumption. Thirdly, the benefits of CE are hard to adopt by SMEs due to resource and knowledge limitations. Fourthly, international cooperation suffers from varied priorities and governance fragmentation. Finally, financing instruments for enabling circular transitions remain missing or inadequately adapted to local context (Kumar et al. 2023).

These challenges affect not only Sustainable partnerships, but may also affect climate actions, which are presented next.

4.2.5. SDG Group 5: Holistic climate action

The final SDG group again encompasses three SDGs and was widely discussed in the field, yielding 76 instances in which contributions to SDGs were found in our review. These contributions were dominated by SDG 13, which is presented first.

SWM systems play a critical role in supporting **SDG 13 (climate action)** because they integrate CE and SWM practices to address climate change (Paes et al., 2024; Tsai, 2021; Ye et al., 2023; Yadav et al., 2021; Voss et al., 2023). Converting landfills to energy production can reduce dependency on raw materials and reduce waste emissions (Mandpe et al., 2022; Whiteman et al., 2021; Kumar et al., 2021; Elsheekh et al., 2021; Ram and Braccio, 2024). Moreover, smart technologies, such as AI, the IoT and robotics, have a significant environmental impact in terms of greenhouse gas emissions (Kurniawan et al., 2022; Zyoud and Zyoud, 2024). Innovations, such as geopolymers, can decrease carbon footprints and are used for climate action goals (Poranek et al., 2022), while converting agricultural waste to bioenergy reduces greenhouse gas emissions, which aligns with efforts to mitigate climate change (Abad-Segura et al., 2020; Craparo et al., 2023; Zhou et al., 2022; Rani et al., 2023; Olabi et al., 2023). Overall, the integration of CE and SWM practices helps reduce CO_2 footprints, which also improves environmental health and societal equity in the long term (Sharma et al., 2021; Fatimah et al., 2020).

CE principles help prevent waste pollution in the marine environment, as covered in **SDG 14 (life below water)** (Ranjbari et al., 2023). Separating and collecting waste at the source can prevent pollution to preserve water quality, and organising community or school campaigns has been shown to reduce the amount of waste disposed of in rivers and water bodies (Ferronato et al., 2024). Marine pollution from plastic waste is a critical issue linked to inefficient SWM systems (Tejaswini et al., 2022b). CE practices can play a role to the health of the aquatic environment through enhanced circularity (Ye et al., 2023) and by promoting sustainable waste management practices and protecting marine life from micro and macro plastics (Sharma et al., 2021; Elsheekh et al., 2021).

To support **SDG 15 (life on land),** CE practices focus on reducing land degradation and conserving biodiversity by encouraging waste reduction, recycling and sustainable land use (Voss et al., 2023; Kadhila and de Wit, 2022; Sharma et al., 2021). Recycling agricultural waste is particularly important for preventing environmental degradation and maintaining sustainable ecosystems on land (Whiteman et al., 2021). For instance, the decline in reliance on virgin wood pulp and its replacement with recycled paper following this policy contributed to resource conservation and reduced deforestation (Li et al., 2025). Moreover, illegal waste disposal in natural environments leads to soil contamination, biodiversity loss and habitat destruction (Voukkali et al., 2024). By decreasing landfill waste, CE practices ease the burden on terrestrial ecosystems, reducing the need for expensive conservation measures (Ye et al., 2023; Awino and Apitz, 2024). CE policies align with SDG 15 by promoting sustainable land use and ecosystem protection through effective waste management (Shabani et al., 2023b; Ram and Bracci, 2024). Waste reduction, recycling and proper management of materials such as wood and plastics play a vital role in in conserving biodiversity, alleviating environmental pressures, and safeguarding natural habitats (Shehata et al., 2022; Elsheekh et al., 2021; Tsai, 2021; Mihai et al., 2021).These strategies reduce pollution and reliance on landfills, thereby supporting the sustainability of terrestrial ecosystems (Mandpe et al., 2022).

Although CE and SWM activities have helped so much in achieving these SDGs, there are some unavoidable issues. For instance, ocean pollution remains difficult to control due to inadequate enforcement of plastic waste laws as well as a lack of global coordination. Moreover, limited data on loss of biodiversity and the long-term environmental impact of landfills render policymaking evidence-based problematic (Parida et al., 2023).

Summarising the results, Table A.1 (Appendix A) presents a cross-tabulation of the sample papers and the SDGs on which they focus. While we presented in this section the focal points per SDG group, the lower part of Table A.1 provides a longitudinal overview of SDG focuses over time. When grouping the papers into more recent ones (Group 1: papers from 2025 to 2023) and earlier ones (Group 2: from 2024 to 2019), Group 1 showed more diversity in SDG coverage and a higher number of publications, while Group 2 highlighted a strong but narrow focus on specific environmental and sustainability-related SDGs. In both groups, SDGS 6, 12 and 13 were central, which underlines their key role in the reviewed field of the CE in SWM.

4.3. Synthesising the literature

Beyond the findings focused on SDG groups presented before, this section systematically connects SWM and CE strategies with SDGs, demonstrating how different CE approaches support sustainable development. Structuring the SDGs, as well as the CE principles, into thematic groups provides a focused link between industrial practices and global sustainability targets. This structured approach ensures that the 10Rs framework is effectively aligned with the SDG goals. Moreover, this study establishes a comprehensive framework that systematically links CE strategies in SWM with SDGs, as illustrated in Table 1 and Figure 5. This is based on the SDG classification (Figure 2) and the 10Rs framework (Figure 1) along with an analysis of the reviewed articles.

In the first synthesis, Table 1 presents which of the 10R groups link to each of the SDG groups based on the cross-tabulation of these codes per paper. In this way, it moves beyond the thematic findings in the previous section, which analysed which papers discussed each SDG. As a result, a distinction can be seen between the 10R groups that link differently to the SDG groups. Most notably, SDG groups 3 and 5 link to only one 10R group, while the other SDG groups link to multiple groups. To facilitate understanding of this distinction, Table 1 explains the links and Figure 5 presents a graphical representation of the overlaps of the links presented in Table 1. It becomes evident that even though SDG Group 1 (social well-being and equity) is the least discussed group, it still links to all three groups of CE principles.

This indicates that there is more potential to be investigated and leveraged, which can also help position the CE in SWM as a driver of sustainability beyond the environmental domain. SDG groups 2 and 4 link to two of the three groups of CE principles. This underlines that R0 to R7, which are covered in the first two groups, rely more on partnerships to leverage their potential, while R3 to R9 need to be monitored for their impact on the working and living conditions of workers and communities in proximity to SWM sites. This is also underlined by the link between the third group of CE principles, R8 and R9, and the climate action SDGs, for which SWM can have a detrimental impact (e.g., Debrah et al., 2021). Finally, the first group of CE principles, R0 to R2, is linked to the sustainable growth and governance SDGs in SDG Group 3. This again underlines their potential for positive change, which deserves more attention at the intersection of CE and SWM research.

[Insert Table 1 here]

[Insert Figure 5 here]

Moreover, Table A.2 and Table A.3 of Appendix A show that some SDGs are more closely related to certain strategies from the 10R framework when it comes to managing SWM. SDG12 and SDG13 are most often connected to R2 and R8. For instance, Reduce is mentioned in 57 papers and Recycle is mentioned in 59 papers that are about SDG12. For SDG13, Reduce is mentioned in 40 papers and Recycle is mentioned in 43. These findings indicate that prior research has predominantly concentrated on recovery-oriented strategies as essential instruments for attaining environmentally SDGs. Otherwise, objectives like SDG10 and SDG16 exhibit no direct correlation with any of the 10R strategies in the examined literature.

This underscores a significant research deficiency, particularly in examining how the CE can facilitate social justice and institutional advancement. R0 and R1 are the least discussed strategies, each mentioned only once. R8 is the most common strategy overall, followed by R2. In general, these results show that most existing research has focused on end-of-life strategies. Less attention has been paid to early-stage and preventive approaches in product design and use. This disparity offers a prospect for subsequent research to investigate how CE strategies can enhance the social and institutional dimensions of sustainable development.

5. Two-dimensional research agenda

This review emphasises the significant role of practices of SWM and the CE in accomplishing the SDGs but also highlights several research gaps that need to be resolved in areas of future research concerned with the integration of SWM and the CE into sustainable development policies. This contributes to answering RQ2 on the current gaps in research on integrating SWM and the CE to achieve the SDGs and what future research directions can address them. To answer this question, we identified a two-dimensional research agenda ordered into four key research areas to be investigated and two transversal directions on how to enrich these investigations. This agenda is presented below and in Figure 6.

[Insert Figure 6 here]

Research area 1: Strengthening the social dimension in SWM and the CE

The social aspect of waste management and the CE is still one of the most important topics for further research, especially on how these practices can be used to fight inequalities, enhance population health and increase social inclusion. To date, research has been pursued in the environmental and economic realms of SWM and the CE, with relatively few studies focusing on their social implications. Future research could study how these practices enable poor communities in low-income or rural areas to gain opportunities for poverty alleviation.

Research area 2: Understanding how technological innovations can drive the impact of SWM and the CE on the SDGs

Technological innovations may constitute a promising direction for future research with a social focus. Advanced technologies, such as hyperspectral imaging and big data analytics, offer great potential for advancements in the efficiency of SWM and resource recovery systems (Menezes et al., 2024). Moreover, implementing blockchains in waste management enhances the traceability and transparency of waste materials and recyclables. It makes data tamper-proof while ensuring data exchange in real time by manufacturers, suppliers and regulators. It enhances coordination and efficient waste management in the CE (Chowdhury et al., 2023). These technologies can introduce automation into waste sorting, optimise waste collection routes and improve the monitoring of waste management processes. We should research how these technologies can be used in settings that make it more difficult to put technology into practice, especially countries with developing prerequisites. The successful integration of these technologies into SWM systems will depend on assessing their scalability and cost effectiveness.

Research area 3: Investigating the future role of policy, governance and cooperation in the contribution of SWM and the CE to the SDGs

SWM and the CE have traditionally been strongly influenced by policy and governance frameworks, and further research on this is required. Support for the adoption of CE practices should be explored via the role of policy instruments such as regulations, incentives and subsidies. Future studies could assess what can be done by governments to create supportive conditions for innovation and collaboration in the waste management area (Ferraz and Pyka, 2023). Moreover, the outcomes of public–private partnerships in advancing the CE should also be examined to encourage sectoral cooperation and accelerate the adoption of practices.

The active participation of communities is the driving force behind the success of CE initiatives. Changing mindsets about waste and resource consumption requires public awareness campaigns, community and resource-driven initiatives and education programs. Where important waste generation reductions and improved recycling rates are most likely to be achieved, behaviour changes at the individual, household and community levels will be encouraged (Al-Dailami et al., 2022). Education on the environmental and economic benefits of waste reduction and recycling, as well as on how the public can actively participate in the CE, should be the focus of future work.

Considering globalised waste streams, the goals of SWM and the CE can only be achieved through further international cooperation. When facing waste management challenges, developing countries often face the extra hurdle of poor infrastructure and a lack of resources. Sharing knowledge, technology and best practices between nations, regions and communities can help mitigate these challenges (Abad-Segura et al., 2020). In addition, international agreements on SWM and CE practices (including controlling plastic pollution and managing e-waste) will need to be fostered to ensure that such approaches for SWM and the CE are universal. In international platforms, research collaborations and multilateral organisations, ideas can be exchanged across different contexts, and solutions can be implemented.

Research area 4: Enabling the CE in SWM in developing countries to achieve the SDGs

Research on the adoption of CE practices is needed in developing countries where waste management infrastructure is inadequate. Financial, regulatory and infrastructure barriers to CE practices prevail in many developing nations (Ferraz and Pyka, 2023). Possible future studies will be dedicated to searching for context-specific solutions and exploring how small-scale, community-initiated waste management programs can be integrated within broader CE frameworks.

Transversal direction 1: Extending the use of CE practices in SWM to better achieve the SDGs

Future research should focus on addressing the gap in integrating CE principles such as repair, refurbish, remanufacture and repurpose into a comprehensive CE framework applied in SWM. It is somewhat natural for SWM to focus, for example, on recycling or recovery, which is also evidenced in our results (see Appendix A.3). Nevertheless, the integration of further R options can open up current business models to new streams of income that can simultaneously benefit the social and environmental SDGs. Specifically, studies should explore strategies to extend product life cycles through repair and remanufacturing and emphasise their role in reducing waste and conserving resources. Additionally, research could investigate innovative technologies and business models that enhance these processes. For all this, we see two key avenues. Future research could reflect the extension of the main CE practices and investigate to what extent R2, R3 and R8 can contribute in a substantial way to the SDGs with low frequencies in our findings, i.e., the SDGs of group 1 (SDG 1, 2, 4, 5, 10) and SDGs 16 and 17. Additionally, it could be investigated how the CE practices with low frequencies can contribute in a substantial way to the SDGs. Again, there can be a distinction of SDGs with already high frequencies, for which we try to broaden the contribution of CE and SWM. Alternatively, future research could investigate the current blind spots of the discussion, which is how CE practices with low frequencies can contribute to the SDGs with low frequencies. This could encompass the creation of social well-being and equity (i.e., SDG group 1) through the Extension of the useful life of the product and its parts (i.e., CE group 2) beyond the highly used R3 reuse, but delving into R4 repair, R5 recondition, or R6 remanufacture. This also underlies the transversality of this research direction, as it clearly intersects with research area 1.

Moreover, it is essential to perform long-term impact assessments of SWM and CE practices. Many investigations are concerned with the short-term benefits; however, investigations into the long-term environmental, economic and social impacts that some of these activities entail are also required (Ferraz and Pyka, 2023). The effectiveness of these practices over time can be best understood from longitudinal studies, which will inform policymakers about resource allocation or policy development efforts towards SDGs.

Transversal direction 2: Extending the range of methods used to improve the achievement of SDGs through SWM and the CE

SWM using the adaptive neuro-fuzzy inference system model is an innovative method for predicting municipal waste generation. This model uses artificial systems, including fuzzy logic and neural networks, to analyse and predict complex and nonlinear data related to waste generation with high accuracy (Adeleke et al., 2022). Future studies could investigate this model for the SDGs.

Moreover, the THDCNN-BCMOA model significantly increases the accuracy of the prediction and classification of municipal waste and reduces computational time. This technique helps identify and manage wet, dry, horticultural and landfill waste and can help improve the efficiency of waste management systems in urban areas (Prakash et al., 2023) more accurately. Future research could investigate the impact of this model on the CE and sustainable development.

6. Conclusion and discussion

This SLR set out to investigate how the currently available literature reflects on the integration of the CE and SWM to contribute to achieving the SDGs (RQ1), identify the current gaps in research on integrating SWM and the CE to achieve SDGs and reveal the future research avenues that can address them (RQ2). In doing so, we enrich to the literature in three ways.

First, our review results systematically revealed the contribution of the CE in SWM to achieving the SDGs, thereby answering RQ1. We identified the traditional strongholds of the CE and SWM in the environmental domains, mainly SDGs 11, 12 and 13, as the most discussed ones (Voukkali et al., 2024; Paes et al., 2024; Tejaswini et al., 2022a). Moving beyond this, we also found literature support for the emerging discussions on the social impact of SWM in SDG Group 1. This is especially relevant in developing economies in terms of reducing inequalities, giving access to safer working and living conditions and creating opportunities for economic growth and innovation (Kadhila et al., 2023). At the same time, the approaches linked to SDG Group 1 can help to reshape globalised waste streams to the Global South away from being an environmental and health burden towards reduced negative effects and an economic opportunity.

This first contribution also has practical implications for policymakers in the Global South and North, who need to acknowledge that their intentions to large-scale circular waste management systems in their countries come with limits and simultaneously create globalised waste streams causing large-scale pollution of soil, air and water. Policymakers in both contexts need to understand which parts of the waste sector can be best managed in their contexts and how, for example, the Global North can support the South in reducing the negative impact of waste management on the environment and public health. It is evident from the results that the CE in SWM can offer multiple interconnected responses to the complex challenges that societies face with waste, on the one hand, and, for example, energy and food challenges, on the other hand. This is the focus of the second contribution, which is explained next.

Second, we investigated the contribution of the CE in SWM to the SDGs by reviewing which CE principles are linked to which group of SDGs, thereby answering RQs 1 and 2. Linking back to the mentioned interconnected challenges, it became evident that the least developed waste management systems, in particular, mainly face the third group of CE principles (recycle and recover). Our combined analysis with the SDG groups underlined that these CE principles critically drive (1) SDG Group 5 on climate action as the only CE group, (2) SDG Group 2 on safe conditions and (3) SDG Group 1 on well-being and equality. This is especially based on problems of the leakage of greenhouse gases, wastewater and pollutants that simultaneously harm local and global ecosystems. At the same time, our results show that there are solutions available to these problems at two levels. These encompass reducing the amplitude of these problems through the first two CE groups and reducing the waste streams and reusing parts of them – to name just two options – and turning at least parts of the problems into secondary resources. The latter can be based on the systematic management of landfills to reduce the pollution they cause while simultaneously leveraging the potential for energy production and employment. The practical implications of this are the creation and implementation of policies that enable the systematic classification and treatment or use of waste. This requires the cooperation of public and private bodies and is ideally open to innovations from local and small-scale initiatives that aim to leverage CE Group 2 on the extension of product life in a way that drives sustainable partnerships (SDG Group 4) and more equity (SDG Group 1). Overall, it is evident that while the CE and SWM are often seen as being in the public domain, private actors of all sizes must play a role in this endeavour. Large-scale producers must take responsibility in enabling CE Group 1 in terms of intelligent product use and production in a way that enables them to reject, rethink and reduce waste streams. Small-scale actors and start-ups can, in cooperation with larger producers, mobilise the CE approaches in Group 2 to extend the useful life of products and their parts. We propose that the latter, in particular, can drive equality by creating income opportunities other than the often more harmful practices of recycling and recovering in CE Group 3. Such recovery usually requires larger-scale operations to avoid excessive pollution caused by, for example, burning waste at too-low temperatures, as is often the case in informal operations.

Third, and beyond the practical implications mentioned above, we propose a two-dimensional research agenda that combines two transversal research directions with four research areas and answers RQ2. This combination is proposed to close the gaps in the current literature and leverage the potential of the CE in SWM to address today's grand challenges in terms of the climate crisis, globalisation of waste streams, including in developing economies, and mobilising technological advances for this. Also for the research agenda, we want to underline that there is an urgent need to drive the development of methods and applications that account for the specificities of the context that are most challenged – that is, end-of-life operations in the Global South that require more formalisation to leverage their environmental, economic and social potentials, as outlined in our framework for the contribution of the CE in SWM to the SDGs (Figure 5).

Finally, SLRs are subject to various limitations and biases (Seuring et al., 2021), which this study aims to minimise. However, the literature search was still constrained by the keywords and theoretical frameworks used, as well as the search within one database, which was Scopus (Sauer and Seuring, 2023). The content analysis–based data analysis was, to some extent, subjective, and even though we followed best practices to control this, other researchers could reach different conclusions when replicating this study. Finally, our SLR could not take the contextual factors of the reviewed studies into account, even though they are surely an important topic in the CE in SWM. We covered this in our research agenda and encourage future studies to move beyond the limitations of our approach.

[Insert Appendix Table A.1 here]

[Insert Appendix Table A.2 here]

[Insert Appendix Table A.3 here]

[Insert Appendix Table B.1 here]

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Appendices

Appendix A.1

Article	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
(Li et al., 2025)											*	*	*		*		
(Almulhim, 2024)		*									*	*	*				*
(Awino and Apitz, 2024)						*			*		*	*	*	*	*		
(D'Adamo et al., 2024)												*					
(Ferronato et al., 2024)						*					*	*		*			
(Giri et al., 2024)						*					*	*	*		*		
(Lerpiniere et al., 2024)			*			*					*	*	*				*
(Mariyam et al., 2024)											*	*					
(Paes et al., 2024)											*	*	*				*
(Ram and Bracci, 2024)			*			*					*	*	*		*		
(Shabani et al., 2024)				*		*					*	*			*		
(Voukkali et al., 2024)			*			*	*				*	*	*		*		
(Zhang et al., 2024)							*		*		*	*	*				
(Zyoud and Zyoud., 2024)											*	*	*				
(Craparo et al., 2023)		*										*	*				
(Govindan et al., 2023)									*			*					
(Halkos and Aslanidis, 2023)												*					
(Iqbal et al., 2023)								*				*	*				
(Kadhila et al., 2023)	*		*						*			*	*				
(Maalouf and Agamuthu, 2023)						*			*		*	*	*	*			
(Mayes-Ramírez et al., 2023)											*	*					
(Oliveira et al., 2023)						*					*	*					
(Rani et al., 2023)							*					*	*				
(Shabani et al., 2023a)								*			*	*					
(Shabani et al., 2023b)											*	*					

Table A.1. Cross-tabulation of sample papers and SDGs they focus on

Article	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
(Velis et al., 2023)											*						
(Voss et al., 2023)								*				*	*		*		
(Ye et al., 2023)						*	*				*	*	*	*	*		*
(Zhang et al., 2023)						*					*	*	*		*		
(Ferronato et al., 2022)												*	*		*		
(Fiksel et al., 2022)			*									*	*		*		
(He et al., 2022)												*					
(Issaoui et al., 2022)						*						*	*				
(Kadhila and de Wit, 2022)						*	*	*				*			*		
(Kurniawan et al., 2022)									*		*	*	*				
(Magazzino et al., 2022)											*	*	*				
(Mandpe et al., 2022)						*		*			*	*	*		*		
(Morais et al., 2022)	*				*						*	*	*	*			
(Olabi et al., 2022)						*	*						*				
(Poranek et al., 2022)							*		*			*	*				
(Ranjbari et al., 2022)			*									*	*	*	*		
(Shehata et al., 2022)	*	*	*			*	*	*	*		*	*	*		*		*
(Singh, 2022)						*					*	*					
(Soni et al., 2022)											*	*	*				
(Tejaswini et al., 2022a)											*	*	*				
(Tejaswini et al., 2022b)											*	*		*			
(Zhou et al., 2022)						*					*	*	*		*		
(Centobelli et al., 2021)												*					
(Do et al., 2021)												*					
(Elsheekh et al., 2021)	*	*	*			*	*	*			*	*	*	*	*		*
(Ferranto, 2021)											*	*	*				
(Kumar et al., 2021)			*				*	*	*		*	*	*				
(Mihai et al., 2021)											*	*	*	*	*		

Table A.1. continued

Article	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
(Panchal et al., 2021)						*	*	*	*		*	*	*				
(Sharma et al., 2021)	*		*			*		*			*	*	*	*	*		*
(Tsai, 2021)												*	*		*		
(Whiteman et al., 2021)	*										*	*	*	*	*		
(Abad-Segura et al., 2020)						*		*	*		*	*	*				
(Bai et al., 2020)									*			*					
(Fatimah et al., 2020)			*			*		*				*	*				
(Govindan et al., 2020)												*					
(Owojori et al., 2020)				*							*	*	*				
(Valenzuela-Levi, 2019)											*	*	*				
(Wright et al., 2019)			*			*	*	*	*		*	*			*		*
	SDG1	SDG2	SDG3	SDG4	SDG5	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG14	SDG15	SDG16	SDG17
2025 (1 paper)	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0
2024 (13 papers)	0	1	3	1	0	7	2	0	2	0	12	13	9	2	5	0	3
2023 (15 papers)	1	1	1	0	0	4	2	3	3	0	8	14	8	2	3	0	1
2022 (18 papers)	2	1	3	0	1	7	4	3	3	0	10	17	14	3	7	0	1
2021 (10 papers)	3	1	3	0	0	3	3	4	2	0	7	10	8	4	5	0	2
2020 (5 papers)	0	0	1	1	0	2	0	2	2	0	2	5	3	0	0	0	0
2019 (2 papers)	0	0	1	0	0	1	1	1	1	0	1	1	0	0	1	0	1

Table A.1. continued

Appendix A.2

Article	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9
	Reject	Rethink	Reduce	Reuse	Repair	Recondition	Remanufacture	Requalify	Recycle	Recover
(Li et al., 2025)			*	*					*	*
(Almulhim, 2024)			*	*					*	
(Awino and Apitz, 2024)			*	*					*	*
(D'Adamo et al., 2024)				*					*	
(Ferronato et al., 2024)			*	*	*		*		*	
(Giri et al., 2024)			*	*					*	
(Lerpiniere et al., 2024)			*	*					*	
(Mariyam et al., 2024)			*	*					*	
(Paes et al., 2024)			*	*					*	
(Ram and Bracci, 2024)			*	*					*	
(Shabani et al., 2024)			*	*					*	
(Voukkali et al., 2024)			*						*	
(Zhang et al., 2024)			*						*	
(Zyoud and Zyoud., 2024)			*						*	
(Craparo et al., 2023)			*	*					*	
(Govindan et al., 2023)			*	*					*	
(Halkos and Aslanidis, 2023)			*	*					*	
(Iqbal et al., 2023)			*	*					*	
(Kadhila et al., 2023)	*	*	*	*	*	*	*	*	*	*
(Maalouf and Agamuthu, 2023)			*	*					*	
(Mayes-Ramírez et al., 2023)			*	*					*	
(Oliveira et al., 2023)			*						*	
(Rani et al., 2023)			*						*	
(Shabani et al., 2023a)			*						*	
(Shabani et al., 2023b)			*						*	
(Velis et al., 2023)			*						*	
(Voss et al., 2023)			*						*	
(Ye et al., 2023)			*						*	
(Zhang et al., 2023)			*	*					*	
(Ferronato et al., 2022)			*	*					*	
(Fiksel et al., 2022)			*	*					*	
(He et al., 2022)			*						*	
(Issaoui et al., 2022)			*						*	

(Kadhila and de Wit, 2022)			*	*					*	*
(Kurniawan et al., 2022)				*					*	
(Magazzino et al., 2022)			*						*	
(Mandpe et al., 2022)			*	*					*	
(Morais et al., 2022)				*					*	
(Olabi et al., 2022)			*						*	
(Poranek et al., 2022)			*						*	
(Ranjbari et al., 2022)			*						*	
(Shehata et al., 2022)			*						*	
(Singh, 2022)			*	*					*	
(Soni et al., 2022)			*							*
(Tejaswini et al., 2022a)			*	*					*	*
(Tejaswini et al., 2022b)			*						*	*
(Zhou et al., 2022)			*	*					*	
(Centobelli et al., 2021)			*	*					*	
(Do et al., 2021)			*	*						
(Elsheekh et al., 2021)			*	*					*	
(Ferranto, 2021)			*						*	
(Kumar et al., 2021)			*	*					*	
(Mihai et al., 2021)			*	*					*	
(Panchal et al., 2021)			*						*	
(Sharma et al., 2021)			*	*					*	
(Tsai, 2021)				*					*	
(Whiteman et al., 2021)			*	*					*	
(Abad-Segura et al., 2020)			*						*	
(Bai et al., 2020)			*						*	
(Fatimah et al., 2020)			*	*					*	
(Govindan et al., 2020)			*	*					*	
(Owojori et al., 2020)									*	*
(Valenzuela-Levi, 2019)			*						*	
(Wright et al., 2019)			*	*	*		*		*	
Sum	1	1	59	39	3	1	3	1	62	8

Table A.2. Cross-tabulation of sample papers and the CE principles they focus on

Appendix A.3

		Intelligent product use and production			Extension of the useful life of the product and its parts					Useful application of materials		
		R0	R1	R2	R3	R4	R5	R6	R7	R8	R9	Number of papers
Group 1	SDG1	1	1	4	4	1	1	1	1	6	1	**6**
	SDG2	0	0	4	3	0	0	0	0	4	0	**4**
	SDG4	0	0	1	1	0	0	0	0	2	1	**2**
	SDG5	0	0	0	1	0	0	0	0	1	0	**1**
	SDG10	0	0	0	0	0	0	0	0	0	0	**0**
Group 2	SDG3	1	1	11	9	2	1	2	1	12	1	**12**
	SDG6	0	0	23	16	2	0	2	0	23	2	**24**
	SDG7	0	0	12	4	1	0	1	0	11	1	**12**
Group 3	SDG8	0	0	13	8	1	0	1	0	13	1	**13**
	SDG9	1	1	12	7	2	1	2	1	11	2	**13**
	SDG16	0	0	0	0	0	0	0	0	0	0	**0**
Group 4	SDG11	0	0	39	25	2	0	2	0	41	6	**41**
	SDG12	1	1	57	39	3	1	3	1	59	8	**61**
	SDG17	0	0	8	6	1	0	1	0	8	0	**8**
Group 5	SDG13	1	1	40	25	1	1	1	1	43	6	**43**
	SDG14	0	0	10	8	1	0	1	0	11	2	**11**
	SDG15	0	0	20	17	1	0	1	0	21	3	**22**
Number of papers		**1**	**1**	**59**	**39**	**3**	**1**	**3**	**1**	**62**	**8**	

Table A.3. Matrix of sample articles, CE principles, and their corresponding SDGs (color coding identifies the cells with highest frequencies)

Appendix B.1

Authors	Year	Journal	Title	Methodology	Country
Li et al	2025	Forest Policy and Economics	Implications of China's foreign waste ban on the global wastepaper trade networks for circular economy and sustainability	Empirical Analysis	China
Almulhim	2024	Sustainability	Toward a Greener Future: Applying Circular Economy Principles to Saudi Arabia's Food Sector for Environmental Sustainability	Case Study	Saudi Arabia
Awino and Apitz	2024	Integrated Environmental Assessment and Management	Solid waste management in the context of the waste hierarchy and circular economy frameworks: An international critical review	Systematic Literature Review (SLR) and Critical Review	Global
D'Adamo et al	2024	Sustainable Production and Consumption	Driving EU sustainability: Promoting the circular economy through municipal waste efficiency.	SLR and Data Envelopment Analysis (DEA)	Italy
Ferronato et al	2024	Waste Management & Research	A Review of Plastic Waste Circular Actions in Seven Developing Countries to Achieve Sustainable Development Goals	Interview, Field Study, and Comparative Analysis	Global (focus on seven developing countries)
Giri et al	2024	Journal of Environmental Informatics Letters	Solid Waste Management in Underdeveloped Countries: Study of Nigeria and Nepal for Achieving Circularity and Sustainable Development Goals	Case Study, Secondary Data Analysis, and Comparative Analysis	Nigeria, Nepal
Lerpiniere et al	2024	Resources, Conservation & Recycling	Official development finance in solid waste management reveals insufficient resources for tackling plastic pollution: A global analysis of two decades of data	Mixed Methods Research, Data Cleaning, Descriptive Statistical Analysis, Correlation Analysis	Global
Mariyam et al	2024	Environmental Development	A framework to support localized solid waste management decision making: Evidence from Qatar	SLR, Framework Development, Stakeholder Analysis, Comparative Analysis	Qatar

Table B.1: Documentation of the final review sample of 64 paper

Authors	Year	Journal	Title	Methodology	Country
Paes et al	2024	Habitat International	Waste management intervention to boost circular economy and mitigate climate change in cities of developing countries: The case of Brazil	Case Study, Comparative Analysis, Field Study, Data Analysis	Brazil
Ram and Bracci	2024	Sustainability	Waste Management, Waste Indicators, and the Relationship with Sustainable Development Goals (SDGs): A Systematic Literature Review	SLR, Thematic Analysis, Descriptive Analysis	Global
Shabani et al	2024	Environmental Sciences Europe	Solid waste characteristics and management strategies at ST Theresa (STT) and Holy Cross (HC) hospitals in Chirumanzu rural District, Zimbabwe	Survey-Based Study, Chi-Square Test and Descriptive Analysis,	Zimbabwe
Voukkali et al	2024	Environmental Science and Pollution Research	Urbanization and Solid Waste Production: Prospects and Challenges	Statistical Analysis, Comparative Analysis, Quantitative and Qualitative Analysis	Global
Zhang et al	2024	Resources, Conservation & Recycling	Sustainable jet fuel from municipal solid waste–Investigation of carbon negativity and affordability claims	Life Cycle Assessment (LCA) and Techno-Economic Analysis (TEA)	China, UK
Zyoud and Zyoud	2024	International Journal of Environmental Science and Technology	Internet of things supporting sustainable solid waste management: global insights, hotspots, and research trends	Bibliometric Analysis, Content Analysis, and Co-occurrence Analysis	Global
Craparo et al	2023	Environment, Development, and Sustainability	Trends in the circular economy applied to the agricultural sector in the framework of the SDGs	Bibliometric Analysis, Co-occurrence Analysis, and Co-citation Analysis	Global
Govindan et al	2023	International Journal of Production Economics	A location-inventory-routing problem to design a circular closed-loop supply chain network with a carbon tax policy for achieving circular economy	Bi-objective MILP Model and Scenario-Based Approach	China, Denmark, South Korea, India, Iran

Table B.1 continued

Authors	Year	Journal	Title	Methodology	Country
Halkos and Aslanidis	2023	Euro-Mediterranean Journal for Environmental Integration	Promoting sustainable waste management for regional economic development in European Mediterranean countries	Malmquist Productivity Indices (MPI, MLPI), Data Envelopment Analysis (DEA): Malmquist Productivity Index (MPI) and Malmquist-Luenberger Productivity Index (MLPI)	European Mediterranean Countries
Iqbal et al	2023	Sustainability	Waste as Resource for Pakistan: An Innovative Business Model of Regenerative Circular Economy to Integrate Municipal Solid Waste Management Sector	Survey, Estimation Model, Recycling Business Model, Revenue Analysis, Environmental Monetary Value Calculation	Pakistan
Kadhila et al	2023	Environmental Science and Pollution Research	A conceptual framework for sustainable waste management in small municipalities: the cases of Langebaan, South Africa and Swakopmund, Namibia.	Mixed-Methods Approach, Comparative Exploratory Case Study, Structured In-Depth Interviews, Document Analysis, Direct Observation	South Africa & Namibia (Langebaan, SA and Swakopmund, NAM)
Maalouf, Pariatamby Agamuthu	2023	Waste Management & Research	Waste management evolution in the last five decades in developing countries – A review	Comprehensive Literature Review, Material Flow Analysis (MFA), Comparative Analysis	Global
Mayes-Ramírez, et al	2023	Sustainability	Urban Waste: Visualizing Academic Literature through Bibliometric Analysis and Systematic Review	Bibliometric Analysis, SLR, PRISMA	Spain
Oliveira et al	2023	Desenvolvimento e Meio Ambiente	Challenges and opportunities for sustainable urbanization and local environmental management	Survey, Descriptive Statistics, Inferential Statistics, Comparative Analysis, Spatial Analysis	Brazil

Table B.1 continued

Authors	Year	Journal	Title	Methodology	Country
Rani et al	2023	Science of the Total Environment	Agro-waste to sustainable energy: A green strategy of converting agricultural waste to nano-enabled energy applications	Literature Review, Comparative Analysis, Case Study, Systematic Framework Development, Qualitative Analysis	Global
Shabani et al	2023a	Circular Economy and Sustainability	Developing a Sustainable Integrated Solid Waste Management Framework for Rural Hospitals in Chirumanzu District of Zimbabwe	Cross-sectional research, qualitative & quantitative methods, surveys, Semi-structured interview	Zimbabwe
Shabani et al	2023b	Circular Economy and Sustainability	Applicability of the Life Cycle Assessment Model in Solid Waste Management in Zimbabwe	SLR and case analysis	Zimbabwe
Velis et al	2023	Science of the Total Environment	Socio-economic Development Drives Solid Waste Management Performance in Cities: A Global Analysis Using Machine Learning	Machine learning models, Random Forest analysis,	Global
Voss et al	2023	Industrial Ecology	A consequential approach to life cycle sustainability assessment with an agent-based model to determine the potential contribution of chemical recycling to UN Sustainable Development Goals	Process-based LCA, techno-economic analysis. Social indicators	Germany
Ye et al	2023	Journal of Environmental Management	How publications and patents are contributing to the development of municipal solid waste management: Viewing the UN Sustainable Development Goals as ground zero	Bibliometric analysis and machine learning	Global
Zhang et al	2023	Journal of Environmental Management	How construction and demolition waste management has addressed sustainable development goals: Exploring academic and industrial trends	Bibliometric Analysis and Machine Learning	China, Pakistan, South Korea, Australia
Ferronato et al	2022	Sustainability	Circular Economy, International Cooperation, and Solid Waste Management in La Paz, Bolivia	Survey, LCA, and MFA.	Bolivia

Table B.1 continued

Authors	Year	Journal	Title	Methodology	Country
Fiksel et al	2022	Clean Technologies and Environmental Policy	Steps toward a resilient circular economy in India	Interviews and surveys	India
He et al	2022	Journal of Cleaner Production	Global knowledge base for municipal solid waste management: Framework development and application in waste generation prediction	Review of databases, regression analysis, and additive models	United States, Portugal
Issaoui et al	2022	Sustainable Chemistry and Pharmacy	Membrane technology for sustainable water resources management: Challenges and future projections	SLR	Global
Kadhila and de Wit	2022	Nature Environment and Pollution Technology	Towards a Framework for Sustainable Municipal Management: The Case of Swakopmund Municipality, Namibia	Mixed-methods, case study design, document analysis, Semi-Structured Interviews (SSIS), and field observation	Namibia
Kurniawan et al	2022	Journal of Cleaner Production	Strengthening waste recycling industry in Malang (Indonesia): Lessons from waste management in the era of Industry 4.0	Case Study Approach, Group Discussions and Interviews, Field Visits, Document Analysis	Indonesia
Magazzino et al	2022	Science of the Total Environment	Waste generation, wealth and GHG emissions from the waste sector: Is Denmark on the path towards circular economy?	Artificial Neural Networks (ANN) and time-series regression	Denmark
Mandpe et al	2022	Waste Management & Research	Circular economy approach for sustainable solid waste management: A developing economy perspective	SLR	India
Morais et al	2022	Environmental Research Letters	Global review of human waste-picking and its contribution to poverty alleviation and a circular economy	Literature review	Global
Olabi et al	2022	Science of the Total Environment	Role of microalgae in achieving sustainable development goals	Literature review, data synthesis and analysis	Global
Poranek et al	2022	Buildings	MSWIBA Formation and Geopolymerisation to Meet the United Nations Sustainable Development Goals (SDGs) and Climate Mitigation	Experimental research and lab-based tests	Poland

Table B.1 continued

Authors	Year	Journal	Title	Methodology	Country
Ranjbari et al	2022	Gondwana Research	Waste management beyond the COVID-19 pandemic: Bibliometric and text mining analyses	Bibliometric analysis	Global
Shehata et al.	2022	Science of the Total Environment	Geopolymer concrete as green building materials: Recent applications, sustainable development and circular economy potentials	SLR	Global
Singh	2022	Circular Economy and Sustainability	Sustainable Waste Management Through Systems Engineering Models and Remote Sensing Approaches	SLR	Global
Soni et al	2022	Sustainable Chemistry and Pharmacy	Challenges and opportunities of utilizing municipal solid waste as alternative building materials for sustainable development goals: A review	SLR and case studies	Developing Countries
Tejaswini et al	2022a	Science of the Total Environment	A comprehensive review on integrative approach for sustainable management of plastic waste and its associated externalities	Literature review	Developing Countries
Tejaswini et al	2022b	Journal of Environmental Management	Sustainable Approach for Valorization of Solid Wastes as a Secondary Resource Through Urban Mining	Bibliometric analysis, techno-economic feasibility assessment, life cycle analysis	India
Zhou et al	2022	Sustainable Horizons	Assessing the sustainability of municipal solid waste management in China 1980 - 2019	Waste aware framework, entropy-weighting method for sustainability scoring	China
Centobelli et al	2021	International Journal of Production Economics	Determinants of the transition towards circular economy in SMEs: A sustainable supply chain management perspective	Confirmatory Factor Analysis (CFA), Structural Equation Modelling (SEM), Survey (212 SMEs in Europe)	Italy, India
Do et al	2021	International Journal of Production Economics	A systematic review of research on food loss and waste prevention and management for the circular economy	SLR	UK, Italy
Elsheekh et al	2021	Journal of Engineering	Achieving Sustainable Development Goals from Solid Waste Plans	Interview	Egypt

Table B.1 continued

Authors	Year	Journal	Title	Methodology	Country
Ferronato	2021	Environmental Development	Integrated analysis for supporting solid waste management development projects in low to middle income countries: The NAVA-CE approach	Use of Wasteaware Indicators, Survey, Life Cycle Assessment (LCA), and Multi-Criteria Decision Analysis (MCDA).	Bolivia
Kumar et al	2021	Journal of Environmental Management	Eco-innovations and sustainability in solid waste management: An Indian upfront in technological, organizational, start-ups and financial framework	Literature review	India
Mihai et al	2021	Sustainability	Plastic Pollution, Waste Management Issues, and Circular Economy Opportunities in Rural Communities	SLR	Global Rural Communities
Panchal et al	2021	Journal of Environmental Management	Does circular economy performance lead to sustainable development? – A systematic literature review	SLR	Global
Sharma et al	2021	Science of the Total Environment	Circular economy approach in solid waste management system to achieve UN-SDGs: Solutions for post-COVID recovery	SLR and case studies	Global
Tsai	2021	Atmosphere	Carbon-Negative Policies by Reusing Waste Wood as Material and Energy Resources for Mitigating Greenhouse Gas Emissions in Taiwan	Trend and Regulatory Analysis	Taiwan
Whiteman et al	2021	Waste Management & Research	The nine development bands: A conceptual framework and global theory for waste and development	Literature review, Conceptual framework	Global
Abad-Segura et al	2020	Sustainability	Effects of Circular Economy Policies on the Environment and Sustainable Growth: Worldwide Research	Bibliometric analysis	Global
Bai et al	2020	International Journal of Production Economics	Industry 4.0 technologies assessment: A sustainability perspective	Literature review, multi-situation decision method, case study	China, Italy, USA, Finland

Table B.1 continued

Authors	Year	Journal	Title	Methodology	Country
Fatimah et al	2020	Journal of Cleaner Production	Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals	SLR, Direct Observation, and Semi-structured Surveys	Indonesia
Govindan et al	2020	International Journal of Production Economics	Achieving sustainable development goals through identifying and analyzing barriers to industrial sharing economy: A framework development	Literature review, expert opinions, multi-criteria decision-making (MCDM) analysis	China, Denmark
Owojori et al	2020	Sustainability	Characterization, Recovery and Recycling Potential of Solid Waste in a University of a Developing Economy	ASTM D5231-92: Standard Test Method for Unprocessed Municipal Solid Waste	South Africa
Valenzuela-Levi	2019	Resources, Conservation & Recycling	Factors influencing municipal recycling in the Global South: The case of Chile	Survey	Chile
Wright et al	2019	Globalization and Health	Circular Economy and Environmental Health in Low- and Middle-Income Countries	literature review	South Africa, Italy, Australia, Germany

Table B.1 continued

10Rs Group	Related SDG Groups	Explanation of Linkage
Intelligent product use and production (R0–R2)	Group 1 (social well-being and equity: SDGs 1, 2, 4, 5 and 10), Group 3 (sustainable growth and governance: SDGs 8, 9 and 16) and Group 4 (sustainable partnership: SDGs 12, 11 and 17)	Reducing waste production and increasing resource efficiency were found to promote innovation, contribute to economic opportunities in a CE and foster knowledge in waste management practices.
Extension of the useful life of products and their parts (R3–R7)	Group 2 (access to safe conditions: SDGs 3, 6 and 7) and Group 4 (sustainable partnership: SDGs 12, 11 and 17)	Enhancing product longevity and reducing the need for new production were found to improve environmental health and create more sustainable communities and patterns of production and consumption.
Useful materials (R8 and R9)	Group 1 (reducing overall inequality: SDGs 1, 2 and 10), Group 2 (access to safe conditions: SDG 6) and Group 5 (holistic climate action: SDGs 13, 14 and 15)	Recycling and resource recovery were found to minimise pollution, preserve natural ecosystems and create sustainable jobs for waste management workers.

Table 1. Linking 10R Groups with SDG Group

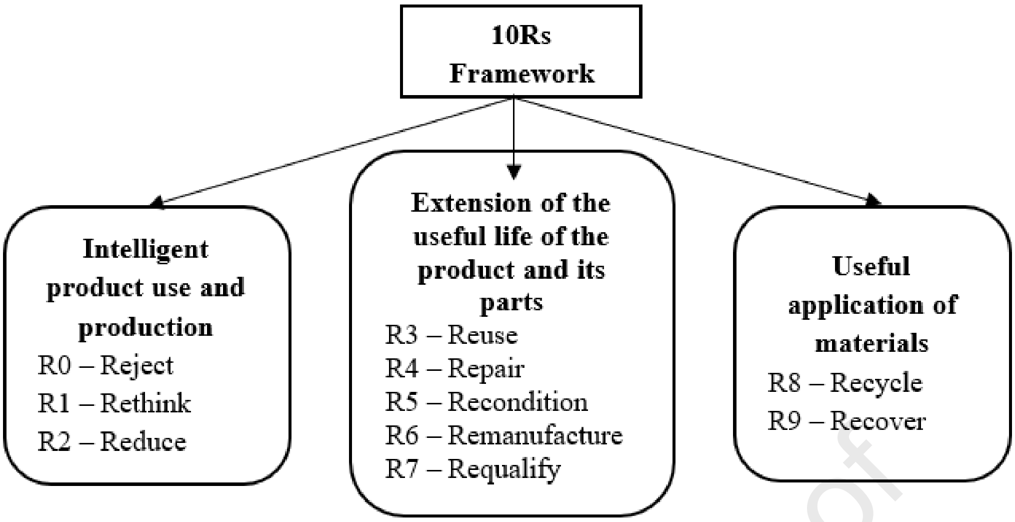

Figure 1. Grouping of the 10R CE principles.

Group 1 (Social well-being and equity)
SDG1: No poverty
SDG 2: Zero hunger
SDG 4: Quality education
SDG 5: Gender equality
SDG 10: Reduced inequalities

Group 2 (Access to safe conditions)
SDG 3: Good health and well-being
SDG 6: Clean water and sanitation
SDG 7: Affordable and clean energy

Group 3 (Sustainable growth and governance)
SDG 8: Decent work and economic growth
SDG 9: Industry, innovation and infrastructure
SDG 16: Peace, justice and strong institutions

Group 4 (Sustainable partnerships)
SDG 11: Sustainable cities and communities
SDG 12: Responsible consumption and production
SDG 17: Partnerships for the goals

Group 5 (Holistic climate action)
SDG 13: Climate action
SDG 14: Life below water
SDG 15: Life on land

Figure 2. Grouping of the sustainable development goals (SDGs).

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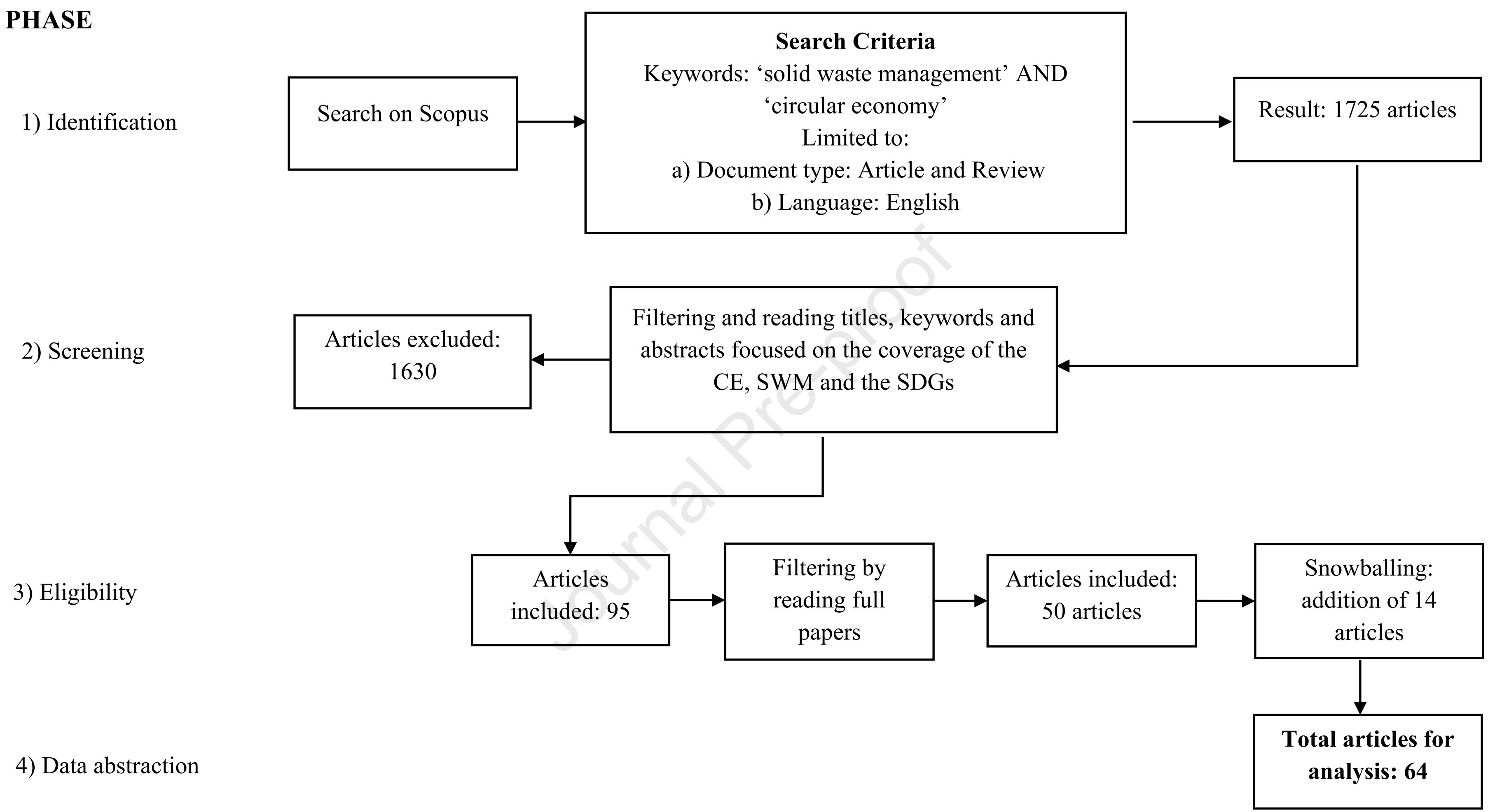

Figure 3. Application of the SLR model.

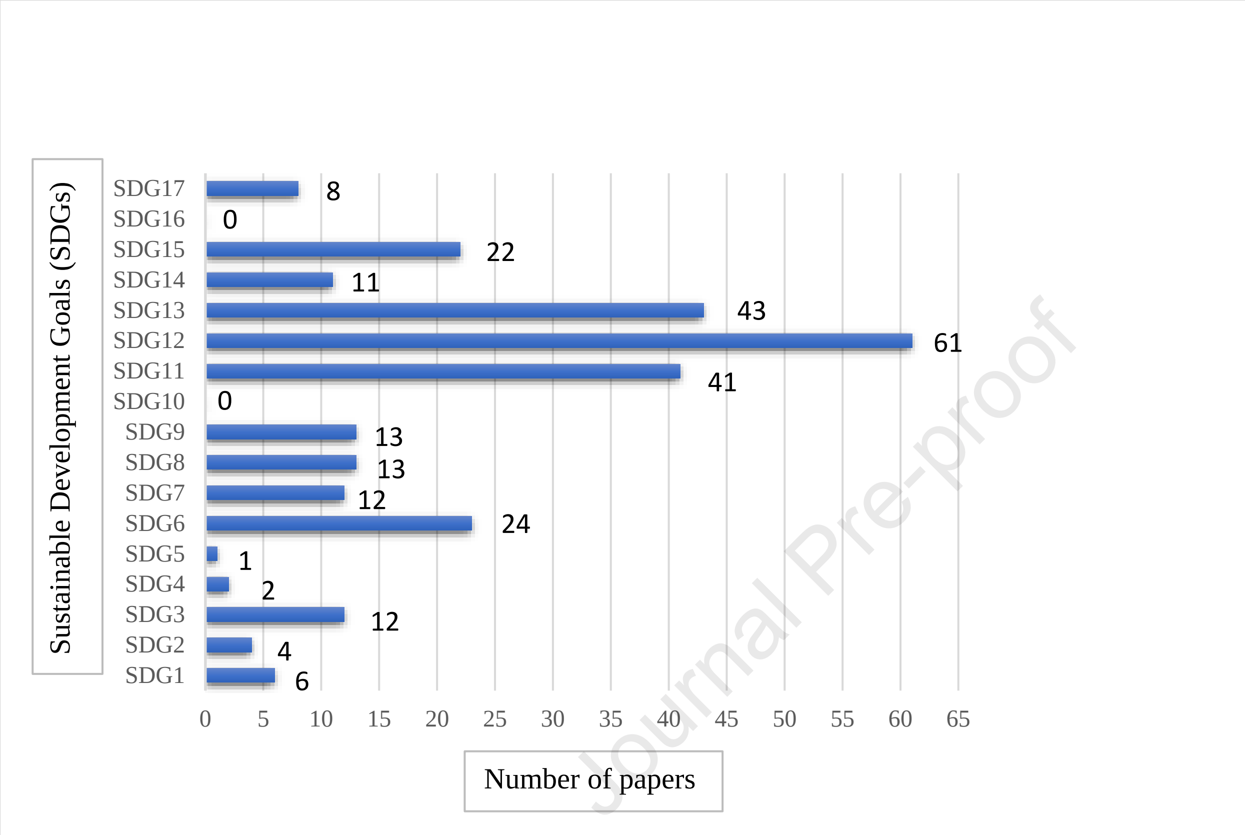

Figure 4. Summary of the SDGs upon which the papers focus (n = 64 papers).

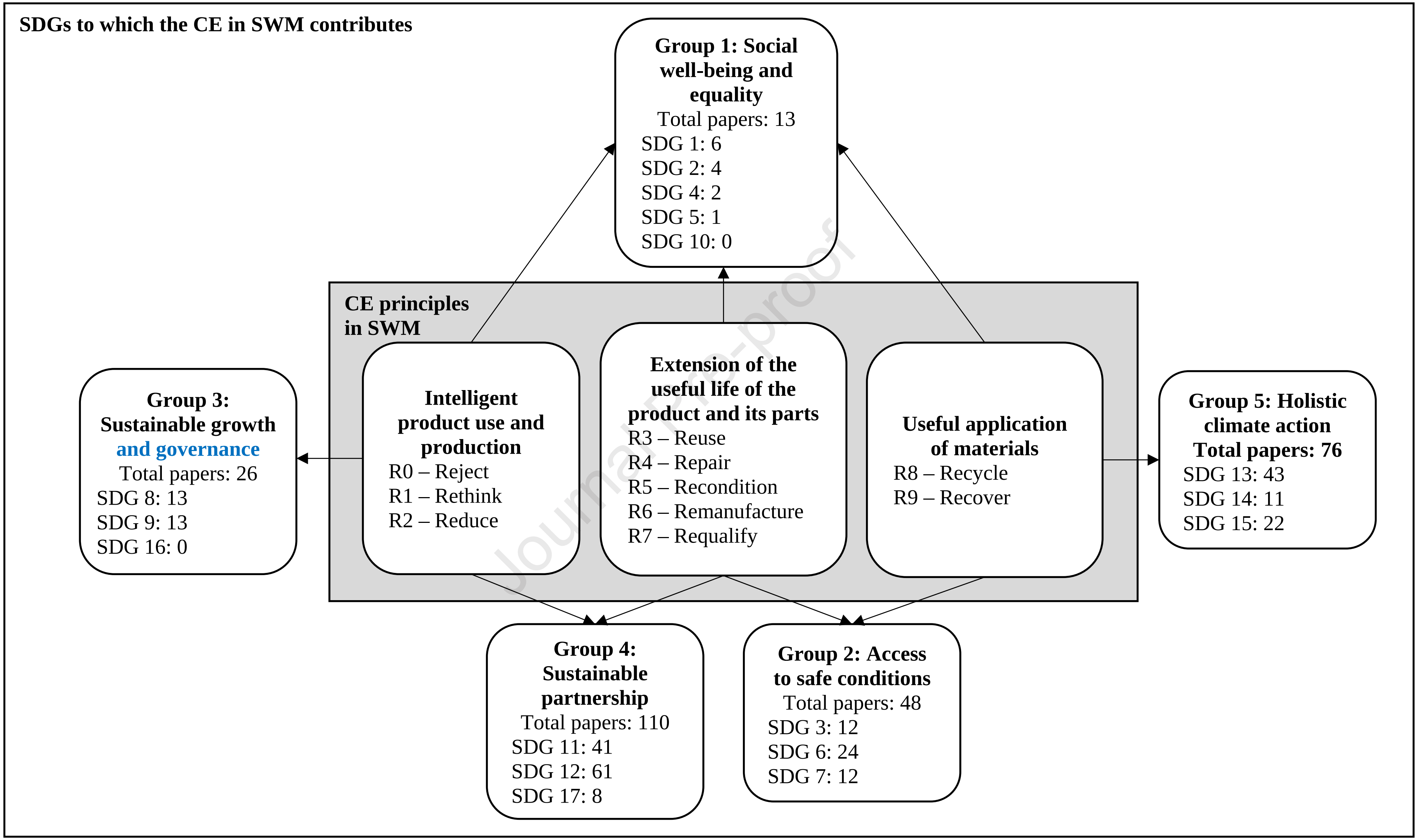

Figure 5. Framework for the contribution of the CE in SWM to the SDGs (total sample: 64 papers; multiple entries possible).

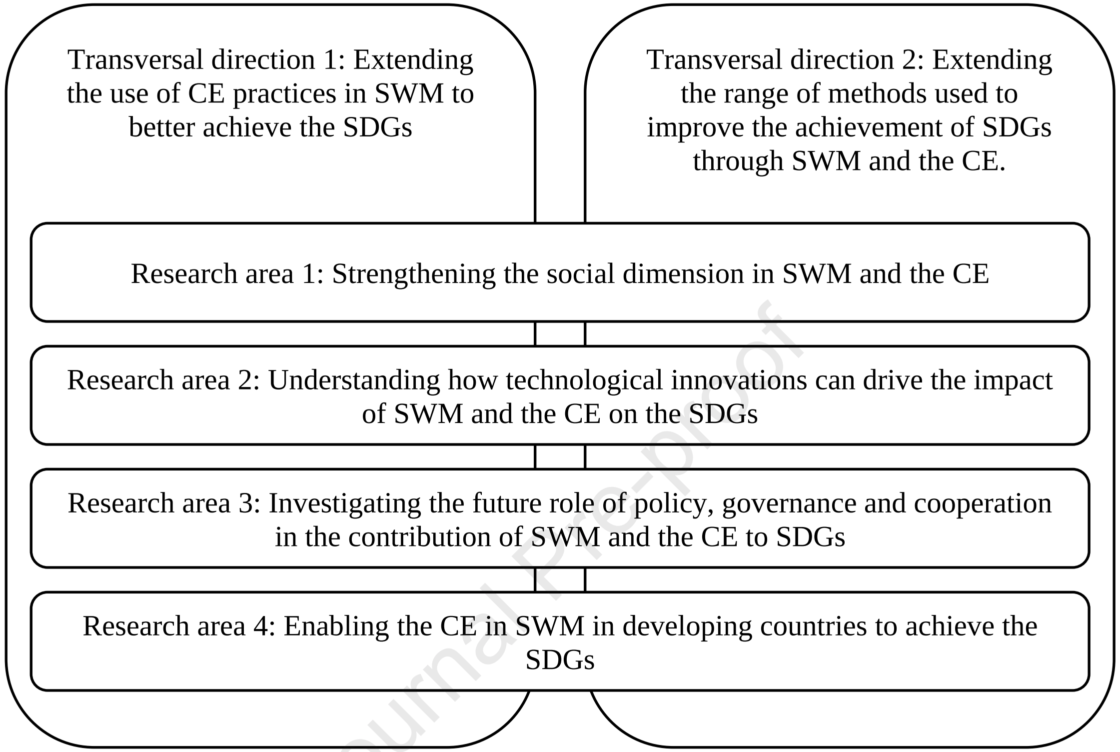

Figure 6. Two-dimensional research agenda to enhance our understanding of the impact of SWM and the CE on the SDGs

„Towards a Sustainable Future: A Systematic Literature Review of Solid Waste Management, Circular Economy, and Sustainable Development Goals"

Highlights

- Systematic review on waste management and circular economy for achieving UN SDGs
- The content analysis reveals potential for social sustainability in the Global South
- A framework for the contribution of the CE in SWM to the SDGs is developed
- A two-dimensional research agenda is proposed to guide future research