A systematic literature review exploring and linking circular economy and sustainable development goals in the past three decades (1991–2022)

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Abstract

Amid the escalating environmental crises and economic disparities, Circular Economy (CE) has garnered recognition as a pragmatic mechanism for achieving Sustainable Development Goals (SDGs). In response, several supply chain organizations are integrating CE strategies into their business operations and production processes. Despite these developments and since the introduction of Business Charter for Sustainable Development by the International Chamber of Commerce in 1991, the academic corpus comprehensively connecting CE research themes, catalysts, deterrents, and practices with the SDGs has remained limited. To bridge this gap, we present a systematic literature review (SLR) of CE research in operations, supply chain and production management encompassing a time span of 31 years (January 1991 – June 2022), by sourcing, screening, and analysing articles obtained from multiple research databases. Our thematic coding analysis generated ten research themes, and subsequently linking them with relevant SDGs. Additionally, we interweaved CE catalysts and deterrents, establishing a connection with the SDGs. This is further enriched with CE strategies aimed at equipping business practitioners to enhance sustainable business performance and contributing to specific SDGs. Lastly, we delineate CE knowledge data management and priority actions frameworks to aid organisations to enhance employee capability and actively leverage digital technologies for implementing CE strategies, i.e., eco-friendly, lean, socially responsible, and financially viable data-driven decision-making.

Keywords: circular economy, systematic literature review, thematic evolution, green and responsible supply chain management, sustainability development goals, sustainable business performance

1. Introduction

The global population doubled in the last fifty (50) years. It is expected to reach 10 billion in the latter half of this century (Gorvett, 2022). Similarly, global resource use has tripled from 27 billion tonnes in 1990 to over 100 billion in 2022 (World Bank, 2022). In the current situation, available natural resources may not be sufficient to cater to the growing global population. In addition, the rise in global warming coupled with environmental pollution puts pressure on the sustainability of the environment. Linear economic production has been identified as an underlying cause of natural resource depletion due to associated toxicity, pollution, and emissions (Schroder et al., 2020). For instance, over 90% of biodiversity loss and water stress are caused by expanding resource extraction and processing (Oberle et al., 2019). It is imperative to slow down the demand and consumption of natural resources, minimise pollution streams of industrial ecology, and maximise the useful life of raw materials.

Circular economy (CE) practices have emerged as an essential agenda in production research due to their ability to mitigate the looming global climate crises. They offer a holistic approach to economic development through waste elimination and pollution reduction, including regenerating natural systems and reusing products and materials (Schroder et al., 2020; Patel et al., 2021). A report by the Ellen MacArthur Foundation showed an almost 30% increase in GDP through the CE pathway in some developing economies (Ellen MacArthur Foundation, 2016). The opportunity, therefore, lies in the lower use of virgin materials, sharing economy, digital revolution, regenerative industrial process, and intelligent and sustainable mobility. Several governing bodies worldwide have adopted CE practices, including the European Union (EU Monitor, 2022) and the People's Republic of China (Bleischwitz et al., 2022), due to their capacity to achieve sustainable development goals.

Since the 1980s, some elements of CE have been discussed in research. However, the formation of the Ellen MacArthur Foundation in 2010 catalysed the research, resulting in an exponential growth of research articles. Over 64% of CE-themed articles have been published since 2016. The increased amount of published literature has brought cognitive, regulatory and moral barriers (Kirchherr et al., 2017). For instance, there is no commonly accepted definition of CE. The European Union defines CE practices as a production and consumption model involving sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials as long as possible (EU Monitor, 2022). However, CE practices transcend material usage to include environmental and economic impacts (Luthra et al., 2022). The Ellen MacArthur Foundation (2013) stresses the importance of restorative system design that encourages maximum cascading of biological and technical nutrient cycles to maximise value over the product life cycle. CE practices are based on three fundamental design principles: eliminating waste and pollution, circulating products and materials to generate the highest value, and industrial ecology designed to regenerate the natural economy.

There is also an increasing number of CE-related thematic topics. These include sustainable supply chain modelling (Luthra et al., 2017; McDougall et al., 2022), closed-loop supply chain (Govindan et al., 2020; Cannelli et al., 2021), waste management (Pluskal et al., 2021; Woodward, 2021; Yu et al., 2021), and carbon emission management (Jimenez-Parra et al., 2014; Collivignarelli et al., 2021), decision support (Atia et al., 2020; Zhou et al., 2021), digitalisation (Ma et al., 2020; Upadhyay et al., 2021; Bag et al., 2022), supply chain decarbonisation (Koh et al., 2023), climate change risks impacting SC resilience (Ghadge et al., 2020), finding synergies between CE, SC uncertainty and sustainable business performance (de Lima et al., 2021), impact of digital technologies on sustainable SC practices and management (Schilling and Seurig, 2022), role of government regulations and policies to enhance motivation of businesses to become low carbon (He et al., 2022), impact of collaborative supply chain management to achieve carbon neutrality in maritime SCs (Kong et al., 2022), delivery schedule optimisation to reduce carbon emissions in logistics sector (Zhang et al., 2022), impact of digital transformation on low-carbon operations management practices (Sheng et al., 2022), notion of regenerative SC and synergies with CE strategies and performance indicators (Howard et al, 2019), and CE strategies for circular supplier selection (Bai et al., 2022), and various other interdisciplinary themes.

These thematic areas and sub-areas sometimes overlap; in other cases, they are borrowed from multiple disciplines, blurring CE boundaries. This may further increase confusion and result in collapse and/or deadlock due to conceptual contention leading to barriers (Kirchherr et al., 2017). Additionally, the blurriness in the conceptual boundaries of different themes can make it challenging for academics and practitioners to map the research domain and place their work. It, therefore, highlights the need for a temporal review across industries and disciplines to examine the development and maturity of CE-related research themes.

There exists a wealth of reviews in the scholarly landscape pertaining to the CE as shown in Table 1 (selected summary of scholarship on CE reviews over the last five years, 2016-2022, following the explosion of CE literature in 2016). However, an analysis of these reviews reveals a degree of divergence in their thematic focal points, often resulting in a somewhat fragmented exploration of the topic. It becomes evident that these reviews pay scant attention to the development of a comprehensive analysis linking CE-related research specifically to operations, production, and supply chain management literature. This analytical omission underscores the fact that the full spectrum of CE implications for these crucial business processes has not been thoroughly investigated. This calls for a more dedicated and systemic analysis that offers a holistic examination of the CE within the context of operations, production, and supply chain management literature, thereby providing a more enriched understanding of this important intersection. For instance, Bag et al. (2022) examined the contribution of Industry 4.0 (I4.0) to CE. Jia et al. (2020) reviewed the drivers, barriers, practices, and indicators of CE in the apparel and textile industry. Govindan et al. (2015) and MahmoumGonbadi et al. (2021) reviewed the literature on closed-loop supply chains (CLSC). Liu et al. (2018) studied organisational theoretical perspectives on green supply chains (GSC) and CE. Shekarian (2020) reviewed the game theory perspectives, cooperation, and competition-related factors in CLSC. These reviews offer specific insights of a CE-related domain, provide essential information and answers to specific questions, and help expand the research domain into new directions. However, the accumulation of an expanding field requires the conciseness and particularity of concepts.

Table 1. Review of Scholarship on CE between 2016 and 2022
(x denotes the information is not available)

Authors	**Number of articles**	**Timeline of review**	**Research focus and key contributions**
Chauhan et al. (2022)	123	2010–2021	Contribution of digital technologies such as IoT, big data analytics and blockchain technology to CE implementation
Rejeb et al., (2022)	170	2007–2021	Systematically examined the role of IoT as an emerging technology in CE adoption.
Awan et al. (2021)	596	2006–2019	Industry 4.0 and the circular economy and identified various I40 tools that can be used with a circular economy.
De Oliveira et al. (2021)	47	2011–2020	The focus was on food loss and waste prevention in relation to CE.
Acerbi and Taisch (2020)	215	x–2019	The adoption of CE principles in the manufacturing sector including technology, evaluation methods and models as research streams.
Bentacourt Morales and Zartha Sossa (2020)	128	2016–2019	Concepts, barriers and trends of CE in Latin America in comparison to Europe were identified.
Do et al. (2020)	297	2002–2020	Food loss and waste prevention management strategies.

Centobelli et al. (2020)	133	2013–2018	Provided a conceptual framework for designing business models in CE.
Jia et al. (2020)	109	1979–2020	Trends, barriers, practices and performance indicators of CE in the textile and apparel industry.
Rosa et al. (2019)	158	2000–2018	Industry 4.0 and CE adoption.
Sassanelli et al. (2019)	45	2009–2018	Performance assessment methods.
Govidan and Hasanagic (2018)	60	2000–2016	CE drivers, barriers, practices and a multi-perspective framework to enhance stakeholders' participation in implementing CE.
Kalmykova et al. (2018)	118	x–2015	CE strategy and implementation databases to develop tools for CE implementation.
Merli et al. (2018)	565	x–2017	Comprehensive CE research to identify gaps and future research strategies.
Kirchherr et al., (2017)	114	x	Analysed definitions of CE.
Ghisellini et al., (2016)	155	2004–2014	CE contributions to sustainable development through production research.
Leider and Rashid (2016)	158	1950–2015	Proposed an implementation strategy for CE in the manufacturing industry using top-down and bottom-up.

The concept of CE and the United Nations' Sustainable Development Goals (SDGs) are inherently interconnected. CE promotes resource efficiency, waste reduction, and recycling, all of which directly contribute to several SDGs, particularly Goal 12 (Responsible Consumption and Production) and Goal 13 (Climate Action). However, the implications of a circular economy reach further, impacting other goals, such as Goal 8 (Decent Work and Economic Growth) by stimulating new job opportunities in recycling and remanufacturing sectors, and Goal 11 (Sustainable Cities and Communities) by promoting sustainable resource usage in urban areas. The implementation of CE principles not only reduces environmental pressure but also creates a viable pathway to achieve the SDGs' economic and social targets. In this context, the interconnectedness between UN SDGs and CE are critical as they guide the global community towards sustainable, equitable growth and resilience, emphasizing environmental sustainability, economic viability, and social inclusivity, and this has been sparsely investigated in the existing CE research reviews, except Oliveira and Oliveira, 2023, Lim et al., 2022, Anton et al., 2019, however each of these studies are context specific. For e.g., Anton et al., 2022 examined the relationship between circular economy initiatives undertaken in the EU and compliance with the SDGs, Lim et al., 2022 explored the impact of green technologies on SDGs, and Oliveira and Oliveira, 2023 examine the impact of CE performance indicators on SDGs.

To address the gaps in the extant literature, we offer a comprehensive and systematic review, taking into account a vast array of extant research spanning over three decades (Jan 1991- June 2022). This approach facilitates a more detailed understanding of the intricate interplays between CE practices and the achievement of Sustainable Development Goals (SDGs), thus offering significant contributions to the field of operations, supply chain, and production management. Considering that both CE and SDGs encompass multiple, interrelated dimensions - namely economic, social, and environmental - a thorough examination of prior studies allows for the discernment of recurring themes, potential synergies, as well as inconsistencies and gaps in the current comprehension. More specifically, our research endeavors encapsulate the following objectives: (a) To elucidate the trajectory of CE literature's evolution over the past three decades; (b) To synthesize key research themes that have emerged from theoretical perspectives and establish their connections with SDGs; (c) To formulate a research agenda that aids in furthering the research trajectory within the CE domain; (d) To proffer theoretical frameworks that will facilitate the transition and adoption of CE within business organizations while simultaneously contributing to the attainment of selected SDGs.

Unlike prior reviews, which tend to scrutinize specific CE concepts within a restricted temporal scope, our study offers a unique exploration of a substantially broader time horizon — 31 years — encompassing approximately 10,000 articles across a variety of databases, therefore offering a significant addition to the extant literature, characterized by its exhaustive coverage. A standout feature of our research is the identification of ten thematic territories, offering a snapshot of the evolving focal areas within CE research and thereby enriching our understanding of this field. In addition, our work highlights the somewhat marginalized economic and societal facets of sustainability within the CE paradigm, thus circumventing the pervasive environmental bias and offering a more balanced exploration of sustainability. Our research review fills a crucial void by drawing connections between CE research themes, drivers, and barriers, and the SDGs, thereby facilitating the recognition of recurring patterns, potential synergies, discrepancies, and gaps in our current comprehension. Based on our findings, we suggest novel theoretical frameworks intended to enhance CE knowledge among employees, enhance data readiness to capitalize on digital decision-support tools for deploying CE strategies, and prioritize actions geared towards the implementation of CE strategies to achieve sustainable business performance. Therefore, our review not only furnishes the academic discourse with emerging research questions and pathways but also provides invaluable insights for practitioners. These insights assist in the more effective deployment of CE strategies to achieve SDGs, cementing our research review's dual contribution to academic and business practitioners.

The paper is structured as follows. Section 2 describes the methodological approach used in this study. Section 3 presented the evolution of CE research over the past three decades. Section 4 discusses the findings of the review followed by the implications in Section 5, and conclusions as well as limitations of the review are presented in Section 6.

2. Methodology

We have conducted a systematic review of the literature following the recommendations by Tranfield et al. (2003) and the updated PRISMA (2020) guidelines by Page et al. (2021). This was to ensure that the review process was transparent and replicable and systematically synthesised research themes. A systematic review helps to understand the breadth and depth of research, its theoretical underpinning, and its limitations in the field (Farooque et al., 2019). Figure 1 summarises the protocol for our review.

2.1. Search strategy

Two search strategy methods were used to collect articles for this review. The first method focused on collecting academic papers published in the Scopus database because of its popularity and reputation as the largest bibliographic database of published scientific peer-reviewed literature. The second strategy involved collecting articles from Web of Science and Business Source Ultimate (EBSCO), Springer, and Informs online databases using the same search criteria for the Scopus database. We chose these publishers because, from observation, many of the journals by these publishing houses were not reflected in the Scopus database.

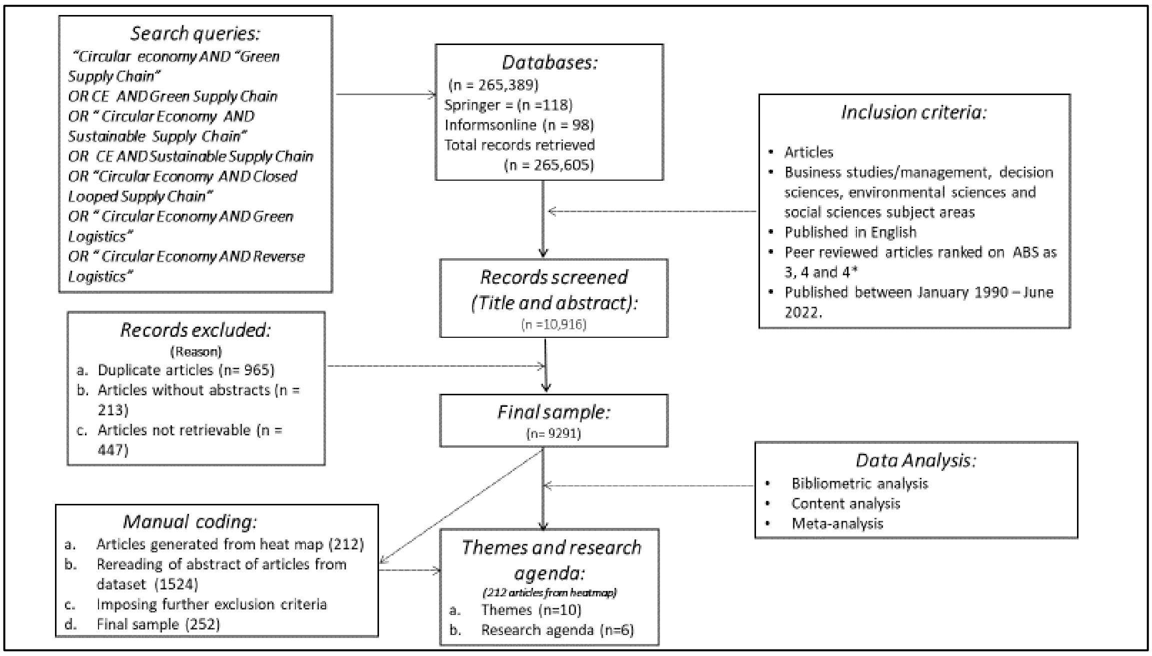
A few studies have also employed bibliometric and meta-analysis in examining CE trends (Rosa et al. 2019; Goyal et al. 2020; Jia et al. 2020; Awan et al. 2021). These studies have various limitations. For instance, Rosa et al. (2019) focused on the role of industry 4.0 (I40) in implementing CE but failed to include the role of sustainability and sustainable development in CE. Alnagem et al. (2021) examined CE trends for a decade (2008-2019) and identified the importance of sustainability and supply chain strategies in the CE domain. Our research thus goes further to surmount the limitations of these earlier works. First, we extended our key search strategy to include sustainability and supply chain strategies such as reverse logistics and closed-looped supply chains. Secondly, we used the meta-analysis technique to understand the topical foci of the field of CE. Thirdly, we situate the themes within theoretical underpinnings to provide research pathways. Thus, the initial themes arrived at in this study emanated from strongly linked keywords, and each theme name was based on the density of the subtheme keywords.

After selecting our database channels, the PRISMA guidelines (Page et al. 2021) and Tranfield et al. (2003) recommendations were used to determine our screening process. It was pertinent to consider the field's diverse dimensions and the volume of significant academic literature to efficiently assess the research on the circular economy (CE). The search string for collecting academic articles from the research database repositories was generated iteratively by examining the author-provided terms in the existing recently published CE articles, strings used in the existing review articles covering CE adoption (see Table 1), and manuscript titles of the most cited articles published in the CE domain (between 2016 and 2023). The terms of the search string were concatenated using Boolean operators. Several filters were imposed (see Figure 2) during the data collection process to ensure that the articles were relevant to the objectives of this review and the theme (CE in business and management, environmental sciences, decision sciences and social sciences domain, reflecting contributions in operations, supply chain and production management literature). After finalising the search string using Boolean operators, we applied several filters to create a database of articles relevant to the theme of the review (see Figure 2). To this end, the search criteria were based on advanced search queries on **Circular Economy* *Green Supply Chain* *Sustainable Supply Chain* *Closed-Looped Supply Chain* *Reverse Logistics** (Bernon et al., 2018; Merli et al., 2018; Piyathanavong et al., 2018) in the title, abstract, and keywords. Standard Boolean operators 'OR' and 'AND' were used. The first step involved screening our initial sample using our inclusion criteria. Our final sample set generated 10,916 online documents from Scopus, Springer, and Informs. After applying our inclusion and exclusion criteria (see Figure 1), 9,291 articles were considered for further analysis.

2.2. Method of analysis

Figure 1. Caption: Research protocol

Figure 1. Alt Text: A figure showing the steps followed in undertaking a systematic literature review, from material collection to research proposition development.



To establish rigour and validate our theme generation, in the data analysis phase, we employed a dual coding process in which four authors from the team reviewed each article (in total 212 articles). We extracted the insights and contributions reported in each article. The information extracted from each article was stored in a data repository (Excel file) comprising the following attributes: (1) reference information; (2) the full abstract of the article; (3) author-generated keywords; (4) whether the article is conceptual, review, empirical, position paper, or opinion piece; (5) theoretical lens used; (6) link to SDG; (7) theoretical and practical implications outlined; (8) methods employed and findings; (9) future research orientation to address limitations of the current work and advance the academic scholarship in the domain; (10) commentary on the relevance to the topic; (11) theme of the paper (first order coding).

By reviewing the bibliography, all additional articles relevant to the theme matching our filtering criteria were included in the review process (total number of articles = 252). After the review stage, all document extraction tables were integrated to develop second-order research themes, primarily using columns c10 and c11 for each article. Next, each theme was linked to SDGs (c6), article type (c4), and theoretical lens used (c5). A workshop was conducted among the team members to finalise and reach a consensus on the key themes from the information extracted in the previous steps (individually). Finally, after linking all the data and articles to the themes, each author was responsible for summarising the literature for at least two themes (a total of ten themes) and one research proposition for that theme. Finally, after a discussion between all the authors and a virtual workshop with eight experts (academic and business practitioners) in the area (operations and supply chain management and CE adoption), the research themes, link to SDGs, emerging research questions and research pathways were revised and finalised.

3. Circular Economy Research Evolution over three temporal timelines

Before 1990, researchers were more interested in energy conservation and pollution reduction (Drand and Sharma, 1982). However, there was a shift in focus to an overall concern for the environment following growing air quality and drinking water issues (Aker and Baggozzi, 1982). Chronologically reviewing CE trends over three decades (1990–2022) reveals the fascinating evolution of research from general to specific insights. This section thus provides a snapshot of the CE trend over the last three decades by highlighting essential milestones.

3.1 Research between 1991 and 1999

Following concerns about the planet's future health, this decade (1991–1999) witnessed a rise in environmental consciousness by governments, consumers, organisations, and international agencies. The International Chamber of Commerce (ICC) (1991) identified 16 environmental principles for managing business operations, encouraging organisations to consider ecological responsibilities when making decisions (ICC 1991). Therefore, the focus of the research here was on evaluating the contributions of environmental management to business practices. These included assessing the incorporation of total quality environmental operation and management, new product development, life cycle analysis, performance measurement of environmental concerns, customer satisfaction, and greening issues in managerial decision-making (Zimmer et al., 1994; Fleischman et al., 1997; Sarkis, 1997; Carter and Carter, 1998; Angell and Klassen, 1999; Stuart et al.,1999). For instance, Zimmer et al. (1994) investigated the relationship between consumers' perceptions of green issues and marketing strategies. Sarkis (1997) designed a model using ANP to aid organisations in assessing the impact of various environmentally friendly alternatives when making business decisions. Fleischmann et al. (1997) reviewed mathematical models for RL to develop a conceptual framework and identify areas for further research. Stuart et al. (1999) used mixed-integer programming models to evaluate complex product innovation costs and environmental trade-offs. Van der Laan et al. (1999) also explored lead-time duration, variability, and total expected cost in production systems with remanufacturing to extend control strategies. The above examples depict methodological research approaches that were centred around developing conceptual frameworks and mathematical models. These researchers explored balancing environmental concerns and competitive viability, which could be achieved through environmentally conscious designs and manufacturing (ECM).

3.2 Research between 2000 and 2010

With environmental concerns gaining ground in this era and environmental legislation becoming stringent, it became expedient for organisations to adopt environmentally friendly strategies in business processes and operations. Thus, the research here was more concerned with enhancing internal business operations that were environmentally friendly. The topic trends in this decade (see Figure 4) included remanufacturing, closed-loop supply chains, sustainable product recovery, inventory policies, sustainable product design, and product returns (Minner, 2001; Georgiadis and Vlachos, 2004; Fuller and Ottman, 2004; Zuidwijk and Krikke, 2008; Li et al., 2009; Yang et al., 2010; Salema et al., 2010; Martin et al., 2010). Examples include Minner (2001), who examined the integration of product return and reuse into the safety stock planning of supply chains. Inderfurth et al. (2001) examined the lead-time effect of stochastic inventory control with remanufacturing. Mahadevan et al. (2003) also investigated inventory policies for remanufacturing. Guide et al. (2003) explored factors impacting production planning and control for closed-loop supply chains that incorporate product recovery. Savaskan et al. (2004) addressed deciding the appropriate reverse channel structure to collect used products from customers. Seitz (2007) also explored the rationale behind product recovery operations and remanufacturing. Nenes et al. (2010) used optimisation procedures to investigate alternative policies for a system where the demands of new products and the returns of used products were stochastic to achieve cost minimisation in an infinite time horizon. The research within this era also identified that CE practices were required at the micro, meso, and macro levels (Yuan et al., 2006; Geng and Dorbestein, 2008). As with the previous decade, most of the methodological approaches employed during this period used optimisation techniques, such as game theory models and semi-structured interviews.

3.3 Research between 2011 and 2022

After over two decades of exploring the landscape of the CE domain, research within this decade focused more on CE implementation, monitoring, control, and performance metrics. Research trends in this period included waste management (Fujii and Kondo, 2018), carbon-friendly emission control, greenhouse gas (GHG) (Cachon, 2014; Diniz et al., 2021), and production processes (Hsueh et al., 2011; Wang et al., 2012; Govidan et al., 2015; Chileshe et al., 2016; Cao et al., 2018). CE implementation concepts such as reuse, recycle, and reduce have taken a foothold (Jahkar et al., 2018). As of 2015, studies gaining ground sought to streamline focus by designing innovative products and processes. For instance, Govidan et al. (2015) developed an inventory model for remanufacturing and product life cycles. We also observed that the studies in this era were specialised and streamlined. For instance, the levels of CE identified in the previous decade (2000–2010) were remanufacturing, closed-loop supply chains, sustainable product recovery, inventory policies, sustainable product design, and product returns including Hatcher et al. (2011). They discussed design for remanufacturing, which is an area of remanufacturing that focuses on designing products to facilitate effective remanufacturability. Particular attention was also given to optimisation and customer satisfaction (Diaz and Marsillac, 2017). There has also been a rise in research trends around the use of emerging technologies within the CE domain. Topics around data analytics and capabilities, Industry 4.0, and blockchain technology to facilitate CE implementation, control, and performance measurement have emerged. For instance, Saberi et al. (2018) examined the drivers and barriers of blockchain technology in CE implementation. Kouhizadeh et al. (2019) used the ReSOLVE model of regenerate, share, optimise, loop, virtualise, and exchange to identify dimensions for blockchain technology in CE.

4. Discussion and Findings

4.1 Research Themes

After the data extraction phase, the acquired information was subjected to coding. This process entailed the methodical grouping of analogous ideas, phenomena, and concepts present within the articles into comprehensible clusters. To guarantee the formation of separate yet comprehensive categories that encapsulate the extensive scope and intricacies of the data derived from the articles, we employed a constant comparison method by means of manual coding. Upon completion, the resulting categories underwent further examination and consolidation to engender broader themes. These themes were extrapolated from recurring patterns, associations, or pivotal concepts that consistently surfaced across a multitude of studies. The ensuing interpretation and analysis of these themes were performed with an emphasis on their relevance, ubiquity, and consequent redundancies. This manual coding allowed us to generate research themes to provide a comprehensive understanding of the current body of literature. These themes are presented below and further illustrated in Table 2, which offers most salient insights across the research articles and a solid foundation for the subsequent analysis and discussion of our study.

Table 2: Research Themes generated through manual coding and topic modelling-based clustering.

Cluster #	Theme	Corresponding keywords	Description	References
1.	Conceptualising and the taxonomy of business models	Systematic, literature review, framework, conceptual models, concept, operationalisation	This thematic cluster concerns understanding CE, including its associated taxonomies.	Murray et al. (2015); Tukker (2015); Ghisellini et al. (2016); Lieder and Rashid (2016); Kirchherr et al. (2017); Urbinati et al. (2017); Govidan and Hasanagic (2018); Kalmykova et al. (2018); Prieto-Sandoval et al. (2018); Merli et al. (2018); Rosa et al. (2019); Sassanelli et al. (2019); Acerbi and Taisch (2020); Bentacourt Morales and Zartha Sossa (2020); Centobelli et al. (2020); Do et al. (2020); Jia et al. (2020); Awan et al. (2021); De Oliveira et al. (2021) Chauhan et al., (2022); Rejeb et al., (2022).
2.	Performance measurements and indicators	Performance, indicators, metrics, efficiency, measurements, circularity metrics, micro level, assessment, index, life cycle thinking	The focus was to identify parameters for measuring CE transition and efficiency performance. It also included developing tools to assess the economic and environmental performance of CE impacts.	Vachon and Klassen (2006); Hussey and Egan (2007); Pishvaee et al. (2010); Buyukozkan and Cifci (2012); Bai and Sarkis (2014); Bourlakis et al. (2014); Broman and Robert (2017); Coelho et al. (2017); Chen et al., (2016); Vodopivec and Miller-Hooks (2017); Shao et al. (2017); Moraga et al. (2019); Mishra and Singh (2020); Ghadge et al. (2020); Wang et al., (2020); Dorr et al. (2021).
3.	Industrial ecology and waste management practices	Production, environmental, food, energy, waste, sustainability, water, life, results, cycle Nutrient recycling, including fermentation. Water management Business models Use of process waste for recycling Embedding land and water waste, recycling, environmental, products, recovery, material, materials, products, study, reverse	This cluster focused on managing waste through nutrient recycling, recovery or reuse.	Dolman et al. (2014); Darghouth et al. (2018); Prosman and Sacchi (2018); Duberg et al. (2020); Mahmoudi et al. (2020); Rufi-Salis et al. (2020); Su et al. (2020); de Olivera Neto et al. (2021); Foteinis (2020); Wang et al. (2020); Kowalski and Makara (2021); Fidelis et al. (2021); Song et al. (2021) García Rodríguez et al. (2013); Othman et al. (2013); Sahling (2016); Xiong et al. (2016); Moshtagh and Taleizadeh (2017) Liao et al. (2019); Li et al. (2019); Paes et al. (2019); Potoglou et al. (2020); Ajwani-Ramchandani et al. (2021); Biachini and Rossi (2021);Cristiano et al. (2021) Pluskal et al. (2021); Woodward (2021); Yu et al. (2021)

4.	SMEs, and entrepreneurs	SME, small business, and social entrepreneurs	The research areas within this theme focused on SMEs, entrepreneurs and CE. The focus was on the challenges of CE adoption, barriers, technology use, waste management, and leadership capabilities. Alternative models for CE adoption by SMEs include institutional orientation and design functions. Cost and benefits of cleaner production in SMEs.	Heras and Arana (2010); Roxas and Coetzer (2012); Van Hoof and Lyon (2013); Bourlakis et al. (2014); Dey et al. (2020); Woodward (2021); Dey et al. (2022); Malik et al., (2022); Soni et al., (2022).
5.	Closed-loop system and sustainable network modelling	Remanufacturing, product, production, techniques, inventory model, costs, returns, demand, policies Green logistics, reverse logistics, waste management, vehicle routeing Long-term behaviour of closed-loop supply chain Embedding CE values in reverse logistics	This thematic area emphasised developing closed-loop systems and models to enhance the transition to CE. These included eco-efficient, POUT, and uncertainty models. The theme also explored the relationship between supplier selection, sustainable supply chains, and environmental performance through the development of appraisal models.	Sbihi and Eglese (2007); Georgiadis and Besiou (2008); Blackburn (2012); Oskir and Basligil (2013); Ozceylan and Paksoy (2013); Silva et al. (2013); Bai and Sarkis (2014); Dou et al. (2014); Govindan et al. (2014); Jimenez-Parra et al. (2014); Mehrsai et al. (2014); Cortinhal et al. (2016); Govindan et al. (2016); Garg et al. (2017); Luthra et al., (2017); Yoon et al. (2017); Bernon et al. (2018); Mishra et al., (2018); Chen and Akmalul'Ulya (2019) ; McDougall et al. (2019); Cannella et al. (2021)
6.	Digitalisation	Digital, technology, blockchain, Industry 4.0, AI, artificial intelligence, digital platform, big data, analytics, digital twin, digital sustainability	Researchers focused on digital technologies' contribution to CE transition and adoption in this thematic area. Key technologies highlighted were Industry 4.0, blockchain technology, digital platforms, and Artificial Intelligence.	Nobre and Tavares, (2017); Pagoropoulos et al., (2017); Gupta et al. (2019); Suárez-Eiroa et al. (2019): Wang and Wang (2019); Kumar et al. (2020); Ma et al. (2020); Bag et al. (2021); Goyal et al. (2021); Upadhyay et al. (2021); Blackburn et al. (2022); Chauhan et al. (2022); Rejeb et al., (2022)
7.	Green human resource management	Human, resources, leadership, agent, behaviours	Studies in this thematic cluster focus on internal organisational factors as levers of GHRM that participate in sustainable	de Los Roisa and Charley (2017); Murray et al., (2017); Muranko et al., (2019); Llorente-González et al. (2020); Padilla-Rivera et al. (2020); Goyal et al., (2021); Chowdhury et al., (2022); Soni et al., (2022)

			business performance. They highlight the importance of humans in CE practices. Addresses the social aspect of CE.	
8.	Policy narratives	Systematically setting targets for operational efficiency, optimisation and green governance Strategies, public policies, legislation	This theme focused on the role of policies in facilitating CE. The research explores the procedures related to job losses due to CE transition, technological adoption, accelerating growth, tax relief, and liberalising waste trading support for eco-industrial parks.	Dhingra et al. (2014); Ding et al. (2015); Francheschini et al. (2016); Ghisellini et al., (2016); Chen et al. (2018); Ketprapakorn (2019); Rosa et al., (2019); Govindan et al. (2020); Hartley et al., (2020); Jia et al., (2020); Llorente-González et al. (2020); Moktadir et al., (2020); Morseletto (2020) van Loon et al., (2020); Awan et al., (2021); Fidelis et al. (2021); Do et al., (2021); Fitch-Roy (2021); Marco-Fondevila et al., (2021); Rejeb et al., (2021); Uphadhyay et al., (2021),
9.	Low carbon management and net-zero	Carbon emissions, environmental resilience, energy and resource efficiency, emission, economic, development, production, sustainable businesses,	This research cluster deals with developing technologies that can be used to reduce carbon footprints in various spheres of life. The aim is to develop low-carbon emission technologies that transcend beyond achieving net zero to generating wealth.	Jimenez-Parra et al. (2014); Benvenuti et al. (2016); He et al. (2017); Genovese et al. (2017); Cheng et al. (2018); Goossens et al. (2018); Mete et al. (2019); De-Giovanni and Zaccour (2019); Xue et al. (2019); Mishra and Singh (2020); Wang et al. (2020); Zhang et al. (2020); Arguilar-Hernandez et al. (2021); Rapp et al. (2021); Collivignarelli et al. (2021).
10.	Eco-innovation and green transition	ecosystems, eco-innovation, digital, clean congruence, sustainability transition, green growth technologies for green transition	The emphasis of this research area is to understand how to measure the impact of eco-innovation on CE practices. Explore how eco-innovation can be used to operationalise CE practices.	Bakker et al., (2014); Murray et al., (2015); Genovese et al., (2017); Pomponi and Moncaster, (2017); de Jesus and Mendonca, (2018); Prieto-Sandoval et al. (2018); Millette et al., (2020) Scarpellini et al.(2020); Keifer et al., (2022); Bag et al., (2022)

4.1.1 Conceptualising and taxonomy of business models

The circular economy (CE) is the most recent initiative for conceptualising the integration of sustainable economic and environmental activities. However, the underlying meaning of CE and its associated taxonomies has remained evasive. To understand these, researchers within this thematic cluster have focused their aim. For instance, Murray et al. (2017) explored the interdisciplinary concept and global application of CE practices. They proposed the inclusion of a social dimension in which human well-being is paramount. Reike et al. (2018) argued that CE in its dominant frame is not new, but there is now a revised CE 3.0 version distinguished by three phases. To conceptualise CE, researchers have leaned into interdisciplinary reviews, a simple juxtaposition of approaches where authors worked in parallel, sequentially, or independently of each other and discipline specific (Marra et al., 2018). These include systematic literature reviews, bibliometric analysis, meta-analysis, and conceptual frameworks from various fields, including environmental sciences, biology, supply chain, government, and healthcare. This suggests that CE is an emerging philosophy rather than an economic model. CE hence should be approached from a systemic perspective, as advocated by the CAS theory, where various parts of the system contribute to the function of the whole. Van Loon et al. (2020) systematically reviewed the existing literature on CE to identify performance indicators. They determined the absence of product redesign and remanufacturing measurements. Goyal et al. (2021) conducted a bibliometric analysis of CE between 2000 and 2019. They found ten essential research themes covering various aspects of CE adoption, including, but not limited to, methods to assess adoption, frameworks employed in practice, the conceptualisation of non-linear business models, and myriad contexts in which CE had been examined in the extant research.

4.1.2 Performance measurements and indicators

Performance indicators evaluate the critical successes of a particular project or programme. Extant literature on CE performance indicators remains scant, especially at the micro-level, and lacks consensus (van Loon et al., 2020). Studies show that performance indicators are required at every phase of the CE transition and for various businesses. Traditional sales models are often matched against remanufacturing models' impacts to record noticeable differences to assess CE performance. With some performance indicators, such as life cycle assessment (LCA), categorising and ranking performance is possible. For instance, Dorr et al. (2021) employed the life cycle assessment to quantify a novel circular food production system's environmental impact and examine CE benefits. They found that energy and logistics CE approaches had a greater impact than the food-cycle production system. Their findings indicated the ability to assess the various components of CE within the food cycle, which aided in identifying areas for improvement. However, LCA does not measure product design or service strategies, such as remanufacturing and upgradability. Bai and Sarkis (2014) developed a KPI toolset to evaluate the sustainable performance of suppliers using neighbourhood rough set theory and development envelop analysis (DEA). However, parameter selection is sensitive. Elia et al. (2017) proposed a reference framework for the CE strategy's monitoring phase, highlighting this need. Arana (2010) analysed the content and objectives of environmental management systems (EMSs) for use in SMEs. Bourlakis et al. (2014) identified consumption, product quality and supply chain responsiveness as performance indicators for sustainability among SMEs. Geng et al. (2012) focused on evaluating CE regulatory policies in China and concluded that there are no indicators to measure CE policies and regulations. Moraga et al. (2019) used combined quantitative micro- and macro-scale indicators to illustrate the classification of preservation strategies such as recycling and life cycle to show that one size does not fit all.

4.1.3 Industrial ecology and waste management systems

CE entails decoupling economic activities by designing waste out of a system to ensure sustainability; thus, recycling materials from waste is essential to close the loop. Extant literature focuses on environmental problems caused by waste generation and disposal, and organisations' failure to adopt waste management strategies. Some reasons include minimal efficiency or cost-saving systems, existing bottlenecks in waste transport, absence of value-added knowledge for waste recycling, and low government legislative and financial support transitions. Seadon (2010) explained that a sustainable waste management system should dynamically incorporate feedback loops and adaptability to divert waste. Thus, transitioning to CE would require identifying leverage points. Othman et al. (2013) reviewed municipal solid waste management options in Asian countries. They emphasised the integration of life-cycle assessment (LCA) to solve the problem. Lockery et al. (2016) concluded that the absence of appropriate construction and demolition waste classifications in private companies hampered successful waste management practices in the construction industry. In the same vein, Cristiano et al. (2021) found data unavailability for end-of-life products and the absence of demand for recycled products to be hindrances to waste management systems. Pluskal et al. (2021) suggested suitable waste treatment using mathematical models focussing on cost and sorting efficiencies. The findings indicated optimal situations for waste management resulted in many waste-to-energy plants.

Possible solutions to waste management adoption have also been identified. For instance, Ilic et al. (2018) explained that waste management can be achieved by strategically reducing the overconsumption of virgin materials and resources, using non-recyclable harmful materials, and enhancing waste management practices in the upstream supply chain, thereby dealing with critical and primary issues during the early stages of the system configuration and network. Ajwani-Ramchandani et al. (2021) found that using technology and appropriate incentives facilitated MNEs' uptake of waste management activities through a longitudinal case study analysis. Further, Biachini and Rossi (2021) designed a waste management model for plastic disposal at sporting events. The emphasis was not on eliminating waste but on proposing an increased collection, sorting, and recycling efficiency. Even though research around CE is evolving, it was observed that most of the analyses adopted experimental techniques, especially case studies. Confirmatory empirical validation was scanty; hence, future studies should seek to provide explanatory evidence of the various subdomains in CE. The research theme here indicates the use of knowledge-based theory to understand the challenges faced within waste management. Thus, firms with the know-how and know-what of waste management processes and procedures must create and transfer knowledge to gain a competitive advantage. Future research should explore these possibilities.

There is a deep connection between food, water, and energy systems. Food and energy systems rely on water to function, and water is required to grow food crops and generate energy. A considerable amount of energy is needed to move water. The food–energy–water nexus may incur an environmental impact, which is crucial to the discussion on CE. The emphasis is on nutrient recycling strategies, closed systems, and the upscaling of waste products. Song et al. (2021) showed that using a black soldier fly could improve nutrient recycling by transforming urban solid food waste into compost for vegetable cultivation. This process had a lower global warming potential compared to incineration. However, Fidelis et al. (2021) found that water did not emerge as a significant concern in CE plans other than energy or waste when examining how the EU's CE action plans for 2015 and 2020 integrated water resources into its CE transition. Kowalski and Makara (2021) described a CE food model of related materials and energy stream flows to prevent environmental pollution. This model included using new technologies, reusing waste and recycling energy, and substituting raw materials with waste and processed waste biofuel. The articles within this thematic cluster highlight the need for policy incentives to promote an integrated virtuous cycle and cleaner production.

4.1.4 SMEs, and entrepreneurs

An emerging research theme is the link between SMEs and CE. SMEs represent over 70% of the global manufacturing population, identified as critical to environmental contamination because they generate over 30% of the waste (Hussey and Eagan, 2007). Current CE research recommends further exploring the relationship between CE and sustainability and examining their influence on business models, innovation systems, and new business forms and structures (Geissdoerfer et al., 2017). Roxas and Coetzer (2012) suggested that the institutional environment contributed to SMEs' sustainability orientation through regulatory and normative elements. Van Hoof and Lyon (2013) used 972 SMEs' empirical evidence to show that waste management provided profitability if adequately harnessed. Woodward (2021) analysed waste from 100 SMEs and found leakage into the household waste stream. This was particularly damaging, as 77% of this waste was biowaste or dry recyclable materials that could have been converted through recyclable programmes. Hiedrich and Tiwary (2013) provided snapshots of the critical challenges faced by SMEs devoted to circular economy practices. They identified operational barriers, including the need to access datasets for conducting credible product life cycle assessments and the requirements for expertise in analysing large datasets. Bourlakis et al. (2014) identified consumption, product quality and supply chain responsiveness as performance indicators for sustainability among SMEs. Another obstacle to SMEs during their transition to CE is the cost of adopting digital technologies. Hillary (2000) explained that SMEs employ outdated technology and have restricted their ability to execute environmentally friendly innovations. Kumar et al. (2020) provided empirical evidence to show that SMEs could transition to CE and adopt more sustainable operations using Industry 4.0 technologies. However, there was a lack of motivation from SME owners. A trending discourse within CE literature is the development of ecosystems and their impact on environmental performance. Through eco-innovation development, entrepreneurs play a primary role as facilitators to force the transformational and radical changes necessary for CE development (Alonso-Almeida et al., 2021). These actors lead the exploration of the product life cycle extension strategies and circular business models, which rely on the circular design of products and services and the implementation of reliable performance indicators (Bakker et al., 2014; Murray et al., 2015; Genovese et al., 2017). For example, Goyal et al. (2021) proposed three types of monitoring indicators or CE practice indicators: product design and innovation (PDI), infrastructure and network (IN), and Systems, Processes, and Resources (SPR). These include practice indicators related to product design, access to environmentally friendly energy and water infrastructure, and reducing carbon emissions.

4.1.5 Closed-loop systems and sustainable supply networks

The increasing need for CE transition has also recognised the need to develop sustainable supply networks that involve contractual relationships between supply chain actors. Thus, an essential aspect of this research theme is identifying sustainable suppliers to improve environmental performance. To this end, some studies have developed models and tools to evaluate the relationship between green supplier selection and environmental performance. For instance, Buyukozkan and Cifci (2012) suggested a fuzzy ANP approach for evaluating green practices in supply chains. Dou et al. (2014) proposed a grey analytical network process-based (grey ANP-based) model to identify green supplier development programmes that will effectively improve suppliers' performance. Akman (2015) employed survey distribution, factor analysis, two-step clustering, and the VIKOR method to identify and model the performance and green selection criteria for supplier selection. Awasthi and Kannan (2016) proposed a fuzzy nominal group technique (NGT)–VIKOR-based solution approach. The integration of the three techniques will identify selection criteria, address qualitative linguistic ratings, and generate rankings and recommendations. Luthra et al. (2017) introduced a systematic framework to evaluate sustainable supply selection using an integrated analytical hierarchy process (AHP), a multi-criteria optimisation and a compromise solution approach. Other studies have also focused on logistics and routeing within supply networks to incorporate sustainability and CE. Sbihi and Eglese (2007) developed a dynamic vehicle routing and scheduling problem (VRSP) model focused on environmental issues, including eliminating hazardous materials concerning road pricing. The complex adaptive system theory and the agency theory provide an appropriate lens through which to evaluate these relationships. The complex adaptive theory suggests that supply chain relationships should be examined holistically (Choi et al., 2001; Pathak et al., 2007). Thus, metrics need to be generated to measure interactions among agents (suppliers), the environmental impact of supplier interaction (including societal and economic effects), and regulations' influence on supplier interactions. Thus, understanding sustainable supplier relationships in the presence of intervening variables needs to be considered within the entirety of the supply chain and not by individual supplier relationships. Also, supplier relationships are conflict-oriented, where trust, power, and goal misalignment may occur in seeking collaboration. The agency theory supports conflict management by developing outcome-based and behavioural-based contracts. It also explains narrow self-interest and, thus, could explain supplier behaviour and patterns in modelling sustainable supplier networks. Future research should identify these issues and use identified theories (CAS and agency) to suggest best practices.

4.1.6. Digitalisation

In recent years, the circular economy (CE) and technology signify two critical industrial models guiding academia and industry. Digitalisation is changing the way organisations do business. For instance, Industry 4.0 provides digital solutions for the industrial sector. This research theme identifies the importance of digital technologies in CE transition and growth. Key indicators include Industry 4.0, blockchain technology, cloud computing, Internet of Things, cyber-physical systems, digital twins, 5G, and big data analytics. Following the resource-based view (RBV) tenets, these digital technologies can facilitate firms' transition to CE by providing unique and valuable resources. For example, Gupta et al. (2019) showed that big data could enhance information sharing among stakeholders in supply chain networks to facilitate the CE transition. Bag et al. (2021) used 124 data points from manufacturing firms to show that the use of Industry 4.0 in manufacturing automation contributes to the circular economy 10 R manufacturing processes (Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover). Rajput and Singh (2019) used the PCA-DEMATEL approach to depict AI as an enabler of CE strategies. Upadhyay et al. (2021) systematically reviewed the existing research. They found that blockchain technology can reduce transaction costs, and improve supply chain performance. Issues regarding the lack of a skilled workforce and technological infrastructure, as identified by Kumar et al. (2021), can be developed to achieve a competitive advantage. Ajwani-Ramchandani et al. (2021) suggested using new technologies to enhance waste management systems. Silk et al. (2020) provided a computer-aided technological framework to guide organisations in their transition to CE, arguing that CE depends on existing in-house stakeholders' experience, as errors are likely to occur (Ma et al., 2020).

4.1.7. Green human resource management

The literature in this thematic area focuses on internal organisational factors. Here, GHRM is considered a lever for CE implementation (Chiappetta Jabbour et al., 2019; Chowdhury et al., 2022; De los Riosa and Charnley, 2017; Goyal et al., 2021; Marrucci Daddi and Iraldo, 2021). It hinges on the idea that successful operational deployment of CE practices relies on human capital skills (De los Riosa and Charnley, 2017; Soni et al., 2022). Thus, the literature on CE requires an intersection with human resource management. This orientation has created a new research stream: green human resource management (GHRM) (Chiappetta Jabbour et al., 2019). For instance, Chowdhury et al. (2022) developed a theoretical model that examines the impact of certain organisational factors, such as leadership, innovation, culture, and skills, on adopting CE practices to improve the sustainable performance of SMEs. Chiappetta Jabbour et al. (2019) proposed another theoretical model based on two components: environmental recruitment and selection, eco-focused training, eco-aware performance assessment and rewards, and green human resources organizational enablers, ecological organisational culture, greens teams, and eco-focused employee empowerment. Goyal et al. (2021) emphasised the importance of implementing reliable GHRM monitoring indicators focused on allocating funds for training and individual skill building. Muranko et al. (2019) highlighted the importance of persuasive communication in encouraging human behaviour in favour of CE.

4.1.8 Policy narratives

A driving force for CE transition and adoption is supportive policies. In this cluster, some researchers focused on the underlying policies and how these could be enhanced to facilitate circular production and consumption. In contrast, others have focused on how policies could be better designed/implemented. For instance, Hartley et al. (2020) used semi-structured interviews to identify the potential of policy initiatives in improving CE practices. These include tax reliefs, liberalising waste trading, support for eco-industrial parks, physical and virtual infrastructure, and awareness campaigns. Wu et al. (2014) explored the effectiveness of waste management policies in China using a DEA analysis approach. Their findings demonstrated that policies backed by incentives are more effective. Morseletto (2020) systematically investigated and identified the role of targets as powerful governance tools for policy initiatives related to CE adoption. Ryen and Babbitt (2022) showed the importance of a comprehensive policy framework, including federal standardisation of date labelling and redistribution policies for CE adoption, as heterogeneous policies are detrimental to CE efforts. Fitch-Roy et al. (2021) examined waste management policy packages in 60 countries to assess how sound policies were diffused into businesses. Their findings suggest that policies were considered ad hoc instruments, and no novelty was identified. Talens Piero et al. (2020) attempted to operationalise product policies using the EU's Eco-design policies.

4.1.9 Low carbon management and net-zero

The CE is a critical step towards a carbon-neutral economy. It is estimated to reduce GHG emissions by 39% and virgin materials by 28%. However, only 8.6% of the global economy is circular, and unfortunately, the proportion has reduced by 0.5% since last year (EURACTIVE, 2021). Based on normative pressures from academics (e.g., Dey et al., 2019; 2020) and policy papers (Ellen MacArthur Foundation, 2017; London Assembly Economic Committee, 2020), there is an unequivocal push for low carbon needs. It requires businesses, consumers, governments, and non-government development organisations to come together and transition from a wasteful linear to a zero-waste circular economic model. Uncoordinated efforts (often in the form of financial subsidies) do not produce sustainable outcomes. As a result, subsidised CE operations fail to live up to the forecasts. A critical question here is how businesses can be circular and profitable, as circularity and profitability are often thought to be mutually exclusive (World Economic Forum, 2015). Several challenges stand between the CE's ambition for a low-carbon future and adopting it in business practice, for example, (i) a deeper understanding of the CE model and its implementation, (ii) a workforce with new skills, and (iii) automation technologies (Tseng, 2018; Unal et al., 2019). A lack of clear understanding of CE, its implementation, and its benefits are probably fundamental challenges across communities. It is often a missed opportunity, since the change management skills required for such a transition are absent. Policymakers and educators must focus on building the soft skills base (e.g., carbon accounting, recycling data management, project management, communication skills) required to transition to the CE model (London Assembly Economic Committee, 2020). Large-scale CE adoption will require automation at a level that may displace up to 30 per cent of the global workforce by 2030. The analysis shows that the social implications of carbon emission and the forms of financing available for low-carbon-focused firms have been under-researched. Other CE tools should be identified with economic benefits. A sustainable future is only possible when the current workforce supports this transition, reskilling, and accessing new employment.

4.1.10 Eco-innovation and green transition

Eco-innovation is an array of technological and non-technology solutions that prevent, mitigate, and facilitate recovery from environmental harm. The literature examining the link between CE and eco-innovation is still nascent. Some studies consider eco-innovation a system of innovative capability interactions that facilitate CE adoption and implementation. For instance, De Jesus et al. (2018) explored the literature to understand the connection between CE and eco-innovation at three levels: macro, micro, and meso. Their findings highlight that the eco-innovation perspective of CE transition requires the interaction of dynamic and holistic factors working within a system. Other studies have sought to determine the antecedents of eco-innovation necessary for CE implementation. Keifer et al. (2019) showed that different combinations of eco-innovation were required for different approaches to CE transition. Scarpellini et al. (2020) examined the outcomes of eco-innovation on CE performance through a dynamic capability framework to demonstrate the importance of environmental management certification when transitioning to CE. Keifer et al. (2021) examined how the various components of eco-innovation contributed to CE implementation at the micro-level. Their findings showed that while small changes contributed to circular implementation, technological solutions did not. Triguero et al. (2022) found financial and technological capabilities to be drivers of eco-innovative solutions for CE implementation.

4.2 Linking Research Themes to SDGs

As the practices of CE are increasingly recognized as essential instruments for the realization of the SDGs, we endeavored to undertake a robust mapping exercise, wherein we paired identified research themes with their corresponding SDGs, thereby shedding light on their degree of alignment. The summarization of this enlightening exercise is succinctly presented in Table 3. The predominant emphasis on ecological aspects, while undeniably critical, has left the equally pivotal societal and economic dimensions somewhat overshadowed. Consequently, we assert that a more holistic approach needs to be adopted. If CE is to be effectively harnessed as a mechanism for accomplishing the myriad goals encapsulated within the SDGs, it is imperative that researchers afford balanced attention to the environmental, societal, and economic dimensions alike. This three-pronged focus would facilitate a more thorough understanding of the dynamic interactions between CE and SDGs, thus enabling the development of comprehensive strategies towards achieving sustainable development.

Table 3: Mapping Themes to Priority Areas and SDGs to develop research questions and pathways.

Clusters	Themes	Priority Areas	Aligning with Sustainable Development Goals (SDG)	Emerging Questions	Research Pathways
1.	Conceptualising and the taxonomy of business models	Taxonomy of CE, its paradigm and business models.	All SDGs	What are the typologies of CE? How can CE be better operationalised?	Establish the various typologies of CE, i.e., resolve cognitive, regulatory and moral barriers as the concept has evolved from CE to digital CE, and I5.0 enabled CE strategies.
2.	Performance measurements and indicators	The need to evaluate CE strategies is essential; there are, however, limited measurement tools.	All SDGs	What measurement tools are required at every stage of the CE transition? How can LCA be better used to assess the performance of circularity products?	Explore the need for CE performance indicators at various stages of CE transition and different stakeholders. Identify performance indicators for CE products.
3.	Industrial ecology and waste management practices	Integration of the nexus into CE transition.	SDG 6 and 7 focus on clean and affordable water and energy. Also, 14, and 15 talk about sustaining life below water and on land. Packaging waste is one of the critical problems leading to such a situation and a focus of the UN Sustainable Development Goal 6, which concerns itself with sanitation.	How can the food–water–energy nexus be integrated into CE concepts? What should stakeholders look out for? How can waste be effectively managed and packaged to improve organisational profitability while reducing its impact on the environment? How can waste be phased out in the manufacturing process? New technologies to facilitate waste management systems.	If water is to be at the forefront of the transition to circularity, water, food, and energy are integrated into the CE concepts. Understanding consumers' preference for waste management practices. Bio-waste, construction, oils, or textiles are collected separately these days. Other directions involve new targets from the real-operated sorting lines and new conditions related to investment for more fractions treated at a single site.
4.	SMEs, and entrepreneurs	Challenges of CE transition by SMEs, including the adoption of digital technologies and waste management for SMEs.	SDG8 promotes development-oriented policies, creativity and innovation and encourages entrepreneurship	How can SMEs adopt technologies to aid the transition to CE? How can SMEs' waste management streams be better harnessed?	Research should focus on the intersection between gender, SMEs and CE practices.

5.	Closed-loop system and sustainable network modelling	The design of efficient close-looped models that reduce waste and generate income.	SDG12 responsible production patterns	How can closed-loop models be designed to reduce waste and generate income under uncertainty?	Quantitative studies to test the viability of these models. Inclusion of social metrics such as collaboration, trust, and conflict in developing supply network models
6.	Digitalisation	Advanced technologies and their uses in remanufacturing, reuse, and recycling.	SDG 9 which focuses on industry, innovation, and infrastructure	How can advanced technologies be used in the CE transition? What technologies are required at what stages of CE?	Exploring the role of I4.0 in carbon management. Developing mathematical and/or optimisation models to measure efficiency gains and cost reduction achievements.
7.	Green human resource management	The focus in on the role of employees within the organisation and HRM practices to facilitate C transition	SDG12 is about ensuring sustainable, responsible consumption and production patterns, SDG 4 to enhance employee knowledge which will lead to achieving SDG 8 on decent work and economic growth	What is the role of HRM in CE transition, and which factors impact adoption of CE practices and subsequent implementation among employees	Qualitative and case studies within organisations to better understand employee attitudes, behaviour and commitment towards CE and green transition, in an inclusive and equitable manner
8.	Policy narratives	Policies that facilitate transition and implementation of CE practices.	All SDGs	What is the optimal level of CE policy packages to support transformation?	CE policies required to accelerate implementation.
9.	Low carbon management and net-zero	Carbon emission technologies, carbon emission financing. Social aspects of carbon emission.	SDG13 about urgent actions required to combat climate change.	How can carbon emissions be better managed to generate income? How can the social aspects of carbon emission be measured?	Further studies should examine carbon emission trading and financing options with more quantitative metrics and carbon emissions' social impacts.
10.	Eco-innovation and green transition	Features of eco-innovation that facilitate CE implementation.	All SDGs	What is the role of eco-innovation in implementing CE practices? What non-technology indicators of eco-innovation are required to measure CE performance? What drives firms' behaviour towards eco-innovation adoption?	Developing indicators to measure CE performance to eco-innovation at microlevels. Understanding the role of the consumer as an innovative agent in CE implementation.

4.3 Linking Barriers to SDGs

Based on the findings presented in previous sections, we analysed the CE inhibiting factors and found that technology, economic considerations, and market perspectives as major challenges (Table 4). Here stakeholders are mostly external to the organization such as government and policy makers. Lack of government and legal standards, regulations, and policies towards incentivizing the organizations, for example in the case small enterprises has been highlighted as major roadblock towards the adoption. Challenges on technical front include bottlenecks related to designing of reusable or recoverable products, lack of knowledge related to intellectual property or patents for in-house innovative technology development, and lack of technical skills and innovation capacity.

Table 4: Linking CE barriers to SDGs.

	Barriers	Description	Link to SDGS
B1	Stakeholders (e.g., policymakers, suppliers', and partners' pressure) and ownership issues	Limited and clear guidelines on how to implement sustainability practices and low carbon initiatives, Lack of CE know-how and proper quality and project standards as well as clear regulations on intellectual property protection for green processes, manufacturing and products and weak legislations and law enforcement, with respect to low carbon initiatives, result into CE practices being unsystematically and insufficiently implemented.	8, 9, 13 because regulatory barriers impact economic growth, industry innovation, climate action plans.
B2	Technology turbulence	While technology for data-driven decision-making and eco-innovation within the processes is available, but the technology ecosystem is very dynamic, where smaller enterprises find it increasingly difficult to understand which technologies they should adopt, rationale for adoption and its potential impact on low carbon business productivity. There is a lack of technology roadmap and blueprint for green and sustainable transformation, which is not just about digital transformation.	9, 12, 13 because technology uncertainty impacts industry innovation, and data-driven green and lean decision-making to achieve resiliency and sustainable business performance
B3	Market perspectives such as new markets, consumer willingness and demand	While consumer awareness and preferences on green products is increasing, reliable information pertaining to product components that can be reused and recycled is often flawed. Both small and large organisations lack suitable processes and mechanisms to understand new consumer behaviours and emerging demands as that will help to develop collaborative relationships with their consumers which will enhance self-motivation to implement green initiatives to become sustainable.	11 and 12 because it impacts crating sustainable societies through responsible consumption of virgin materials.
B4	Economic considerations such as cost, investment, etc.	High investment or transition costs (new technologies, R&D); Perception of sustainability as a cost and not as an investment; High costs of research and development and building the supporting logistics, High purchasing cost of environmentally friendly materials by the supplier; Production costs are getting higher; Material tests can be very expensive. However, lack of suitable green project management strategy and tools to understand the impact of these strategies makes it difficult for smaller enterprises within the supply chain to understand	7, 8, 9, 13, primarily it impacts using renewable clean and green energy sources that will help achieve sustainable business performance.

		return of investment, which will increase their motivation and commitment towards sustainable practices.	
B5	Conceptualization, design, implementation, and operations of sustainable practices	Lack of mature and integrated regulatory environment, readily available business cases evidence on benefits and complexity of supply chains including the multitude of stakeholders involved in product development and process innovation, limited knowhow on measuring the short- and longer-term benefits of green projects makes it difficult to make the right decision for implementing low carbon practices efficiently.	7, 8, 9, 11, 12, 13, primarily cognitive barriers impact suitable and systematic implementation which have a traversal impact on SDGs concerning business innovation, sustainability and growth.
B6	Top management commitment	Small organisations in the supply chain are focussed on financial gains and profitability to survive day-to-day business operations, which is the top priority of the senior management. Limited training, certifications on environmental management, knowledge, understanding and benefits of green practices, how to implement them, where to start often deters top management from adopting green initiatives, which are often considered as capital intensive, without exploring the business benefits in terms of productivity and reputation.	8, 9, 10, impacts decent work, economic growth and social sustainability – especially equitable growth by reducing inequalities.
B7	Organisational culture and mindset	Limited managerial experience to implement green strategies and knowhow on change management and communication mechanisms that will help to develop internal cooperation among employees through a shared vision, collective goals and clear strategic interventions to become sustainable. Moreover, while green skills and experiences within the workforce is often limited, businesses fail to identify and leverage existing tacit experience of their employees, which in most cases are highly specialised involving both years of training and on-the-job learning.	4, 8, 10, primarily linked to reskilling and upskilling employees which will lead to decent work, industry innovation and inclusive and equitable green growth
B8	Employee Workplace Wellbeing	Smaller organisations within the supply chain network are competing against big multinationals and feel this competition intensely. Therefore, employees often have long working hours and to survive in the competitive environments cut corners (reduced workforce) to reduce operating costs. This small workforce structure requires staff to often fulfil multiple roles (job spill over, increases role ambiguity within jobs, limits job flexibility and satisfaction, which all leads to psychological distress, job stress burnout, depression and work-life imbalance, directly impact employee productivity, organisational capacity for green change and innovation and sustainable business performance	3, 4, 10, 11, primarily linked to creating a conducive work environment which is safe, secure and caters to the needs of the workers, in particular values human workforce and continuously promotes opportunities for career progression and development, which would lead to business resiliency, sustainability and productivity.

4.4 Linking CE Drivers to SDGs

Based on the findings presented in previous sections, the rising energy costs, increasing price of raw materials, government regulations and policies and climate change initiatives across the globe makes it crucial for all organisations irrespective of their size and sector they operate to become energy and resource efficient, optimise their business processes, transform their business model from linear to circular that will result into reducing operational and production costs, without undermining the quantity and quality of the throughputs. The volatile, uncertain, complex, and ambiguous business environment requires organisations (especially smaller ones) to be productive, environmentally friendly, resilient, and responsible, which can be achieved by adopting low carbon and socially responsible employee-centric practices driven by CE and lean philosophies. We outline the drivers for adopting sustainable practices in Table 5

Table 5: Linking CE drivers to SDGs.

Sr. No	Drivers	Description	Link to SDGs
D1	Government policies, support, and legislation	Policymakers across the world (both in developed and developing economies) have introduced various initiatives such as carbon pricing and taxing, Environment Social and Governance (ESG) audits, financial access and credits to buy eco-friendly conversion technologies, and trans-national partnerships for knowledge exchange and transfer bringing together representatives of relevant stakeholders from both sides, including governments, businesses (including start-ups), academia and research institutes (e.g., EU-India Circular Economy Partnership), which will help motivate organisations to adopt low carbon energy and resource efficient initiatives to achieve sustainable business performance	3, 7, 8, 9, 11, 12, 13, 17, policies and regulations will enhance business motivation to become green, socially responsible, and also consumer preferences towards green and ethically sourced products, making CE initiatives demand driven.
D2	Climate change and global warming initiatives across borders	United Nations Sustainability Development Goals, European Green Deal, Paris Climate Change Agreement, COP26 conference, support for companies in the development of personnel training oriented to sustainability at multiple levels (e.g., actions aimed at individuals, firms, companies) from World Economic Forum have facilitate collaborative partnerships and constructive dialogues (through workshops), and showcase successful business cases between all stakeholders to enhance partnerships between SC stakeholders, NGOs (such as Ellen Macarthur foundation), Higher Education institutions, technology providers that will help guide firms to adopt low carbon initiatives and understand its impact on achieving sustainability.	3, 7, 8, 9, 11, 12, 13, 17 Non-governmental organisations create awareness among business and society which contributes towards making sustainable choices and business decisions, contributing to equitable, inclusive and green growth as well as productivity
D3	More opportunities for job creation	Implementing low carbon practices and strategies as a result of CE adoption within firms will facilitate energy and resource efficiency, which will enhance their economic performance, and therefore create jobs within the community, which will also contribute to strengthening the regional economy.	8, 9 and 11 CE strategies will lead to sustainable business performance and profitability (cost savings), which will provide opportunities to reinvest in workforce and society.
D4	Availability of technology	Currently technology is available for SMEs to make data-driven green decisions objectively and monitor the impact of the low carbon initiatives over time. In this context, vast amount of data generated within the organisational processes can be used as inputs to analytical frameworks and systems to gain valuable	8, 9, 12 and 13 Purposeful, cautious and judicious use of digital technologies will lead to making eco-friendly decisions which will lead to SC

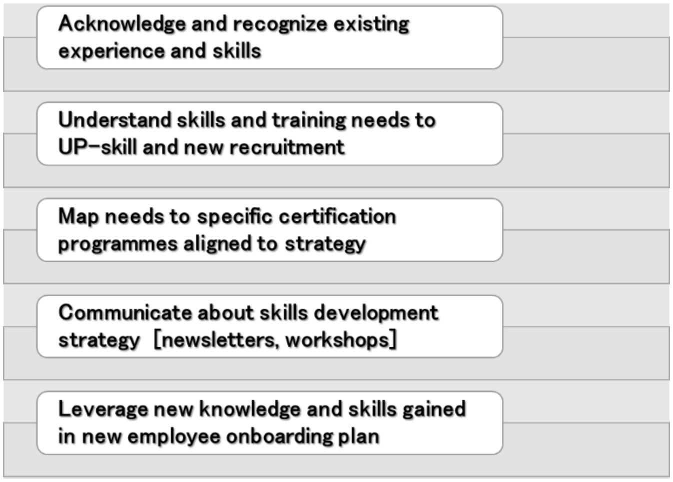
		and objective insights on the efficiency of the existing processes that will help inform and derive low carbon measures to enhance sustainable business performance.	sustainability, agility, and resilience.
D5	Local sourcing	SMEs will turn their focus more on sourcing of products or materials from manufacturers within their region (city, state, country), to implement energy efficient logistics, which will create more financial opportunities for organisations within the region to form partnerships. This will help to enhance the overall financial health of the industries within the economy and sustainable economic growth.	9, 10, 11, 12, 13 and 17 This will lead to cost savings stemming from energy and resource efficiency, minimise carbon emissions and thus contribute to economic growth and building sustainable communities through socially responsible practices and ethical sourcing.
D6	Organisation policy, environment management system, workplace wellbeing	The organisations can access and obtain various ISO certifications corresponding to various dimensions such as environment, project, quality and standards, health and safety, and social responsibility which will help to enhance organisational flexibility and dynamic capability for making strategic changes and process interventions to become sustainable and simultaneous economic productivity. This will help to upskills workforce, job satisfaction, and commitment towards green and sustainable changes, thus minimizing the friction and potential forces of inertia impeding business productivity	3, 4, 8, 9 and 10 This is key to enhance employees' organisational commitment, job satisfaction, risk proclivity, and change management capacity to help drive implementation of new practices and green management innovation at both process and practice levels.
D7	Energy and resource efficiency	The energy costs have increased in the past couple of years and the cost of raw materials have also followed suite. Therefore, low carbon sustainable practices can help drive SMEs to become energy efficient and reduce consumption of virgin raw materials, which is not only help them achieve sustainability but also enhance their economic performance by lowering operations and production.	7, 8, 9, 12, 13 This will be significant in business process optimisation which will minimise waste, minimise green house gas emissions and thus improve overall financial health and throughput of organisations.
D8	Generating revenue and cost savings, and enhancing reputation	The cost savings from becoming energy efficient (low carbon footprint), using waste as input (reducing consumption of virgin raw materials to achieve resource efficiency) will lead to potential new revenue streams and gaining profit. Achieving sustainable business performance will also provide a competitive edge in the business ecosystem through access to government funds, receiving tax credits and enhancing the reputation as a sustainability champion and innovator.	3, 7, 8, 9, 11, 12 and 13 This is critical to improve brand reputation through innovative value proposition to consumers and stakeholders demonstrating innovation capability and simultaneously embedding principles of green and socially responsible management practices and processes.

4.5 Proposed Frameworks

Considering the drivers and barriers, our first framework (Figure 2) contributes to developing skilled workforce (SDG 4), which will be instrumental in achieving SDGs 5, 8, 9, 10, 11, 12 and 13, by effective implementation of CE strategies focusing on all dimensions of sustainability. We are yet to come across a framework in the operations, supply chain management and production management literature which provides strategies linking them to SDGs, except the framework integrating the role of coordination, cooperation, and collaboration in production-inventory systems (Ghasemi et al., 2022), which primarily focuses on contractual practices, joint decision-making practices, and information-sharing practices (i.e., more on stakeholder relationships in SC). To bring about the necessary systemic transformation, it is paramount that organisations train their workforce with requisite skills, expert knowledge, and competencies. These fundamental elements will bolster the capacity for organisational change. In this context, firms ought to be well-versed and proficiently trained in ISO 14001, an internationally recognized standard delineating the prerequisites for an environmental management system. Application of this standard can significantly augment an organisation's environmental performance. This enhancement is achieved via the incorporation of lean management principles that champion resource optimisation and waste minimisation, thus aiding in the diminution of the carbon footprint. Consequently, these enterprises can secure a competitive edge and cultivate the trust of stakeholders and consumers alike. It becomes incumbent upon the managers to establish mechanisms that promote knowledge exchange, co-creation, and dissemination of environmentally conscious practices, circular economy business models, and business process reengineering among employees. These mechanisms should elucidate the purpose, advantages, and contexts of application within business activities and existing workflows. The goal is to foster an internal communication forum that underscores the importance of these practices to the employees. Additionally, this mechanism should incorporate measures to archive information in a manner that is easily accessible to all employees. Such an undertaking necessitates the development of a comprehensive knowledge management strategy, taking into account the investment in technical resources like information systems and platforms that facilitate efficient information storage and dissemination (Chowdhury et al., 2022b). Furthermore, the strategy should stimulate the creation of novel knowledge through processes of reorganization, amalgamation, and synthesis. This knowledge should be allowed to evolve incrementally and iteratively, drawing upon the lessons learned from contemporary practices and successful business cases.

Figure 2. Caption: Framework to enhance employee knowledge about CE (SDG 4) significantly impacting SDGs 5, 8, 9, 10, 11, 12 and 1.

Figure 2. Alt Text: A figure showing five recommendations provided as a list in rectangular boxes to enhance knowledge of workforce about CE practices, strategies and potential impact.

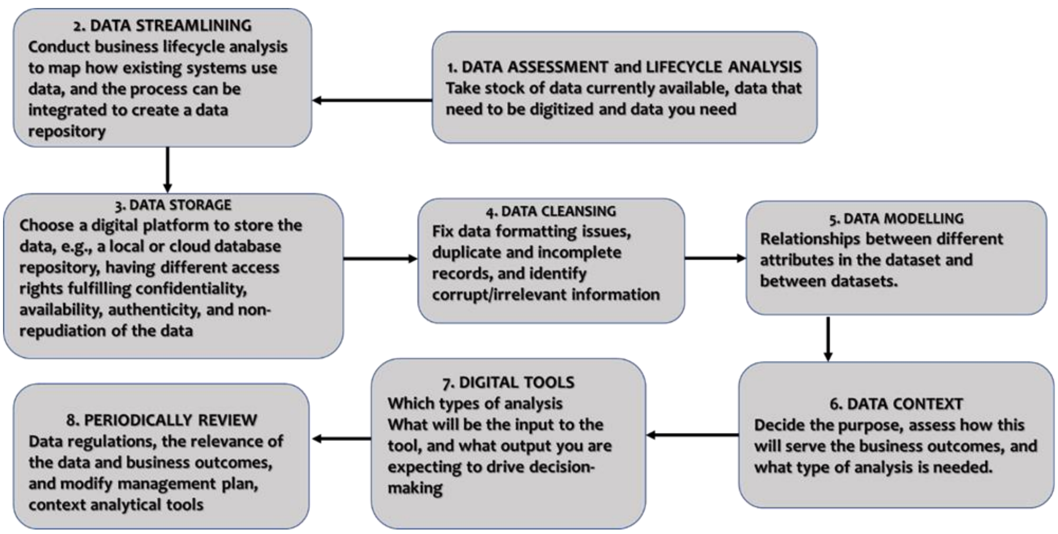


The review underscores the escalating relevance of digital technologies in enabling data-guided business decisions, which subsequently facilitates the strategic formulation of circular economy (CE) practices. While recent investigations demonstrate the importance of (I4.0), big data, artificial intelligence (AI), and the emerging (Industry 5.0) in the deployment of lean, eco-friendly, robust and agile strategies towards sustainable and resilient supply chains (SCs), the attention dedicated to data readiness and management is comparatively limited. Moving away from traditional AI techniques that primarily identified patterns in large datasets for prediction purposes, the advent of generative AI allows production of unique content solely based on user prompts, fostering a more dynamic and conversational interaction between AI and humans. By synthesizing data from varied sources, generative AI can even support businesses in offering substantiated sustainable-oriented strategic recommendations (Budhwar et al., 2023). To fully leverage the capacity of generative AI (or any form of analytical tool) in automated and smart decision-making—which can enhance business process optimization, lean management, productivity, and resilience—organizations need to first achieve 'data readiness.' This involves building the requisite capabilities, capacity, and strategies to treat 'data' as an indispensable organizational asset. Hence, we propose a data management framework (Figure 3) to assist organizations in systematically and critically examining their data requirements, readiness, storage needs, processing capabilities, data usage context, and regular review of data regulations and data-driven strategies. This proposed framework offers crucial, practical guidance for organizations to engage in context-specific, purpose-driven analytics.

Existing frameworks reported in recent literature such as those by Enang et al., 2023, Sharma, 2023, Cannas et al., 2023, Liu et al., 2023, and Schilling and Seuring, 2023, provide insightful perspectives on the benefits of leveraging digital technologies to attain sustainability. These advantages encompass the optimization of waste management procedures, enhancing resource and process efficiency, and mitigation of greenhouse gas emissions via the implementation of green practices. However, our research diverges from this contemporary focus and retraces its steps to the rudimentary stage of data management. We posit that managing data effectively is the foundation within this expansive schema, a keystone from which all subsequent steps emanate (WEF, 2023). By dedicating attention to this initial stage, we aim to provide guidance that will facilitate the intelligent employment of digital technologies and analytical tools. Efficient data management not only ensures the integrity and accuracy of the data feeding into these technologies but also streamlines the subsequent analysis and interpretation processes (Chowdhury et al., 2023b). This can significantly enhance the value derived from these digital technologies and analytical tools, allowing for more informed decision-making and improved operational efficiency. Thus, we believe our back-to-basics approach represents a crucial adjunct to the current discourse, ultimately contributing to the more effective implementation of CE strategies to achieve sustainability.

Figure 3. Caption: Data management framework that will help organisations to drive data-driven green, socially responsible, and financially viable business decisions.

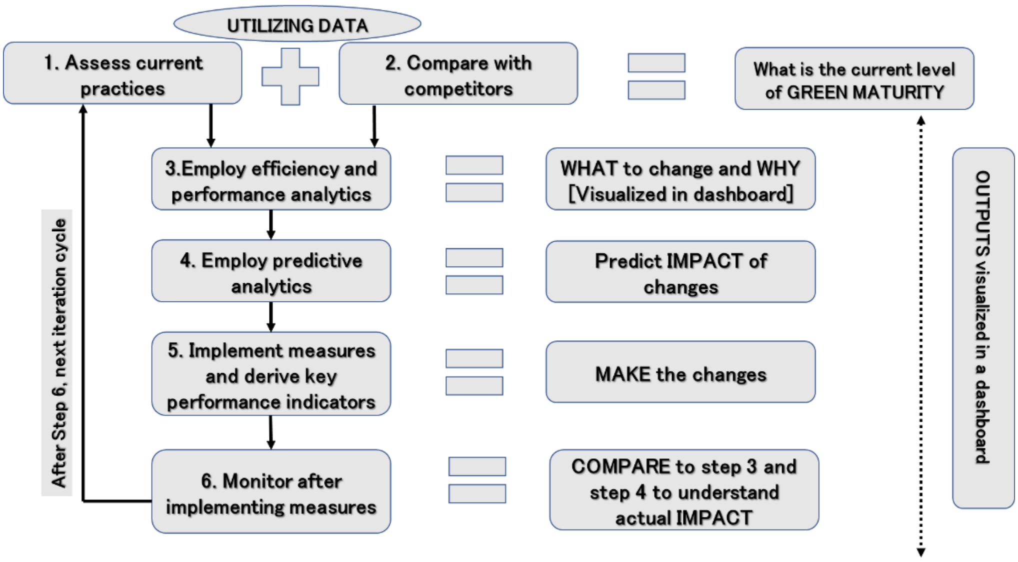
Figure 3. Alt Text: A figure showing eight steps presented in square boxes and connected using directional arrows that will help organisations to enhance their data readiness, data management practices, and therefore capability to use digital analytical tools and expert systems.



Data-driven green decision-making represents the process of scrutinising data, accrued from various organisational processes such as energy consumption, water usage, throughput, cost and quality metrics. The analysis of such data provides invaluable insights into both efficient and inefficient processes, offering a clearer perspective on how organisations can tactically strategize their low carbon initiatives. This method is frequently dubbed 'smart decision-making' due to the unique combination of managers' subjective tacit expertise in their respective domains, aligned to business priorities, and the objective findings emerging from data analysis. This amalgamation facilitates informed decision-making, enabling firms to consistently monitor and reflect on the ramifications of their current green-oriented strategies and practices on sustainable business performance. In this vein, the data analysis derived from a digital decision support system, enabled with data analytics capabilities, can serve as a catalyst for the adoption, implementation, evolution, and strategic planning of sustainability-oriented innovative practices within the industry. Such systems may encompass a host of functionalities that allow organisations to: (1) evaluate their current state of practices and position their organisation within the green maturity model; (2) compare their existing practices with other organisations through clustering methodologies; (3) visualise strategic interventions and recommendations tailored for the organisation; (4) visualise the potential impact on business sustainability, competitiveness, and alignment between business goals, priorities, and key performance indicators, both before and after the implementation of the recommended interventions. In essence, the data gleaned from business lifecycle analysis, when fed into a digital support system, will assist in the extraction of critical insights related to sustainability interventions applicable to the organisation, as illustrated in Figure 4. This approach promises a more coherent and effective pathway towards achieving sustainability through CE strategic initiatives, thereby aligning the organisation more closely with its green and socially responsible objectives.

Figure 4. Caption: Purpose-driven Analytics framework

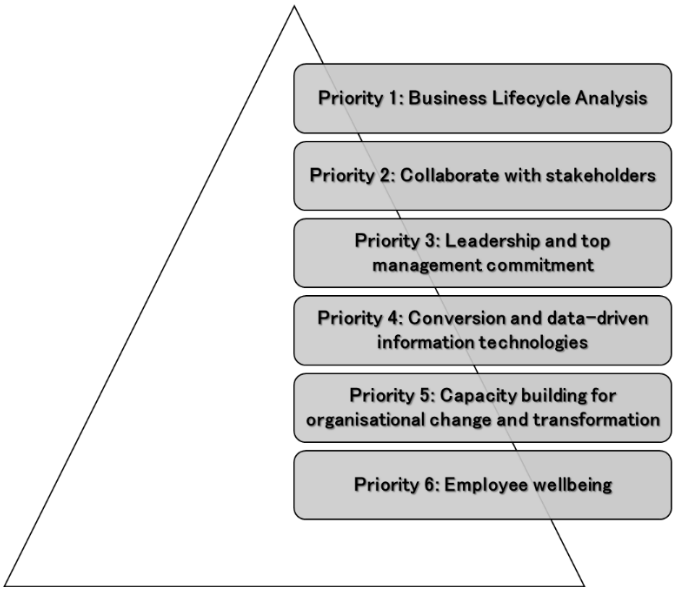
Figure 3. Alt Text: A figure showing presented as flowchart and connected using directional arrows that will help organisations to engage in purpose-driven analytics to enhance their CE strategy and sustainability interventions as well as initiatives.



Finally, we present the priority framework which integrates all our findings and previously presented frameworks to furnish organisations with a clear action roadmap to facilitate the adoption and implementation of CE strategies (Figure 5). This blueprint seeks to clarify the hierarchy of strategic steps essential for transitioning towards CE, thus guiding organisations through the sometimes-nebulous path to sustainable operations. The framework emphasises the importance of sequencing in the adoption of CE strategies, ensuring that each action leads seamlessly into the next, ultimately fostering a systematic and effective transition. Each priority strategy within the framework is designed to resonate with the unique needs and contexts of organisations, thus rendering it a versatile tool for enhancing sustainable operational efficiency and effectiveness.

Figure 5. Caption: Priority framework.

Figure 5. Alt Text: A figure showing six action points presented in square boxes that will help organisations to systematically build CE capabilities.



Organizations can integrate low carbon practices ingrained in the Circular Economy (CE) paradigm by assessing their present operational practices spanning across the organizational value chain - from design, procurement, production, distribution, consumption, to recovery. By utilizing business lifecycle analysis, they can ascertain their sustainability or 'green' maturity. It is vital to possess cognizance of CE practices and sustainability performance, a task requiring the active involvement of both policymakers and their customers. Policymakers must engender an equitable competitive landscape via policy regulations in green practices. In contrast, customers can potentially offer a competitive edge for undertaking green initiatives. The implementation of low carbon practices, a result of CE adoption, necessitates a top-down approach where the leadership assumes a pivotal role. They are responsible for formulating apt strategies for their organizations and mobilizing the requisite resources.

Additionally, the commitment of employees to convert these strategies into tangible actions is instrumental in incorporating sustainability across the various value functions. For the fostering of sustainable product and process innovation, it is important to concurrently consider conversion technology and data-driven green decision-making. The selection and subsequent usage of conversion technology will hinge upon the outcomes of business lifecycle analysis (i.e., understanding the current state of reduction, recycling, and recovery practices). Here, data should be captured and stored in a repository to leverage various analytics forms, with collaborative engagement with academic practitioners. While adopting CE driven practices, firms should strategize for process standardization using ISO 14000. A capacity-building initiative at community and regional levels through the integration of diverse stakeholders (industry practitioners, academics, policymakers, and end customers) should be enacted to facilitate the adoption of sustainable green practices. The wellbeing of employees should be accorded the highest priority. Both economic and environmental performance hinge on employee productivity as employees empower firms to be dynamic, drive innovation, and embrace change. Furthermore, corporate social responsibility (CSR) investments should target employee upskilling, and the creation of new jobs should be considered as a metric for assessing the social performance.

5. Research Implications

5.1. Theoretical Implications

Several dimensions have been identified in our comprehensive review of CE-related literature leading to the following theoretical implications. First, there has been a proliferation in the literature, which began in 2016. Similarly, over the years CE-related research has become more streamlined and more focused. For instance, broader research areas such as the need to match environmental concerns to business practices have become more focused on understanding how production processes could be more efficient such as closed-looped modelling (see Zimmer et al.1994; Bai and Sarkis; 2014). Moreso, the need to enhance customer concerns increased studies on developing sustainable supply chains. There was also increased research on innovative capabilities, especially emerging technologies such as AI, I4.0 and blockchain technologies in addressing business operations (Bag et al. 2021; Chauhan et al.2022; Rejeb et al., 2022). More considerations for research on the human-related aspect of CE such as GHRM practices and leadership capabilities. This has become pertinent as CE-practices cannot be achieved without a more holistic approach (Chowdhury et al., 2022).

The review has highlighted that although CE practices are considered pertinent in achieving SDGs, the The analysed literature highlighted that although CE practices are considered pertinent in achieving SDGs, the research is more concerned with the environmental dimensions of SDG goals. For instance, seven of the ten themes identified focused on environmental improvements, including waste management, carbon emissions, the food–water–energy cycle, and closed-loop networks. Only one dimension focused on matching internal organisational capabilities with human resource practices. There were a few considerations for societal and financial dimensions. It is pertinent to suggest that if CE practices are expected to contribute to enhancing SDG goals and sustainable performance, more consideration should be given to other SDGs, including the role of gender in CE practices as well as CE financing. Similarly, we identified CE as an interdisciplinary concept in which there are blurred lines between research domains. For instance, research into carbon emission reduction borrows concepts from engineering. Similarly, of these, digitalising is the latest and rapidly developing theme, followed by food–energy–water management. All of these themes have been discussed in detail to help the reader understand their significance and get a sense of future directions for each of these themes. Several future research pathways were identified from the analysed data. For instance, we found that in studies relating to CE practices and SMEs, there was limited focus on the use of cost-effective technologies in enhancing implementation. The literature was also scanty on the intersection between CE practices, leadership capabilities, and GHRM practices. Similarly, it would be interesting to explore the role of gender in the entrepreneurial ecosystem and CE practices. There was also limited attention paid to the education of CE practices, which is essential in achieving SDGs.

Based on these themes identified, we developed a conceptual framework (Figure 4) that includes enablers, challenges, and outcomes of CE adoption and implementation. We argue that understanding the enablers of CE adoption provides a standpoint for overcoming challenges, and CE adoption will lead to measurable outcomes for achieving SDGs. Based on the principles of reduce, reuse, and recycle, CE practices can deliver through their practices of take, make, distribute, use, and recover (Dey et al., 2022, and 2020; Rodríguez Espindola et al., 2022). It entails accessing raw materials (take), to product manufacturing (make), then distribution, and then product use by the consumer. Lastly, recovery facilitates the "end-of-the-life state" of the product through reuse and recycling. Finally, strategies, resources, and energy efficiency are important to facilitate CE adoption. Moving towards CE will help increase resource efficiency by keeping the highest values of the materials as well as keeping varied materials, components, and products in the economy as long as possible. This will help in reducing or eliminating not only waste but also the extraction of virgin materials as inputs for production. Economic considerations such as policy and regulation development towards incentivising CE adoption and the development of supplier networks with low environmental impact further pull organisations towards CE adoption (Chowdhury et al., 2022).

5.2 Practical Implications

Supply chains, which inherently encompass the conveyance of commodities and materials, the expenditure of energy in fabrication and dissemination, as well as the discarding of waste, bear a substantial onus for the prevalence of greenhouse gas emissions. The pursuit of carbon neutrality within the ambit of supply chain management is a formidable endeavour, encompassing a panoply of stakeholders from the spheres of supply, manufacturing, logistics, and retail. In the ensuing discourse, we delineate how strategies driven by the principles of the CE can act as a fulcrum, empowering organizations to contribute towards the attainment of SDGs.

- *Resource Optimization (SDG 1: No Poverty):* Enhancing resource efficiency through comprehensive business lifecycle analysis can diminish production costs by eradication of superfluous and iterative processes, thereby rendering products more accessible, affordable and contributing to poverty reduction.

- Equitable Commerce (SDG 2: Zero Hunger): Integrating equitable trade standards within supply chains will help guarantee just remuneration for farmers and producers, subsequently fortifying food security.

- Well-being and Safety Standards (SDG 3: Good Health and Well-being): Adherence to stringent health and safety standards in production processes will help safeguard employee well-being and therefore mitigates potential environmental health hazards, demonstrating care for workers and safe as well as secure working practices.

- Knowledge Dissemination (SDG 4: Quality Education): Augmenting employee expertise on circular economy and sustainable practices will help bolster comprehension and realization of these principles, i.e., effective adoption and implementation.

- Workforce Parity (SDG 5: Gender Equality): Guaranteeing equal opportunities for all genders in manufacturing, production, operations management and supply chain positions will help foster overall gender equality, and these can be achieved by reporting the data about SC professionals and workers in a more transparent manner which can be both audited and verified.

- Water Conservation (SDG 6: Clean Water and Sanitation): Incorporating strategies to curtail water consumption and enhance water waste management, recycling and reusage practices in manufacturing and production processes can help bolster sustainable water footprint management.

- Renewable Energy Adoption (SDG 7: Affordable and Clean Energy): Transitioning to renewable energy in manufacturing and production processes can help mitigate greenhouse gas emissions, which will facilitate lowering carbon footprint, and thus endorse benefits of affordable and clean energy.

- Service-Based Models (SDG 8: Decent Work and Economic Growth): This model can stimulate job creation and economic growth by shifting emphasis from product ownership to service provision.

- Digital Innovation (SDG 9: Industry, Innovation and Infrastructure): Digital technology can augment resource efficiency, waste monitoring, and comprehensive process optimization.

- Equality in Supply Chains (SDG 10: Reduced Inequalities): Implementing equitable trade practices and ensuring equal opportunities within supply chains can mitigate income and opportunity disparities.

- Waste Management Strategies (SDG 11: Sustainable Cities and Communities): Effective waste management strategies, including recycling, composting, and waste-to-energy, will contribute to more sustainable urban environments.

- Recycling and Upcycling (SDG 12: Responsible Consumption and Production): These practices advocate responsible consumption by prolonging the life cycle of products and materials, thereby reducing the need for additional resource extraction.

- Emissions Mitigation (SDG 13: Climate Action): Strategies such as renewable energy utilization and efficient transportation can significantly decrease a company's carbon emissions.

- Biodiversity Conservation (SDG 14: Life Below Water and SDG 15: Life on Land): Sourcing raw materials in a manner that safeguards ecosystems contributes to the protection of biodiversity in both terrestrial and marine environments.

- Supply Chain Transparency (SDG 16: Peace, Justice, and Strong Institutions): Encouraging transparency and accountability within supply chains, businesses can foster peaceful and inclusive societies.

- Collaboration and Partnerships (SDG 17: Partnerships for the Goals): Establishing partnerships with other businesses, government bodies, and non-governmental organizations can magnify the impact of CE strategies and contribute to large-scale sustainable development.

- Sustainable Procurement (Crosscutting): This strategy aligns with numerous SDGs by ensuring materials sourcing is sustainable, equitable, and responsible, thereby promoting overall sustainability in the manufacturing and production process.

6. Conclusion and Research Limitations

As we conclude our systematic review and analysis, we underscore significance of CE strategies as a salient mechanism for achieving the UN SDGs. Our expansive review spanning 31 years elucidates the evolution and trajectory of CE within the domain of operations, supply chain, and production management. The emergence of ten pivotal research themes, their intricate interplay with the SDGs, and the complex web of catalysts and deterrents to CE, have all been comprehensively examined. This academic endeavour provides much-needed clarity and conceptual guidance to both researchers and practitioners who navigate this multifaceted field.

Moreover, we contribute to the existing body of knowledge by suggesting pragmatic CE strategies aimed at sustainable business performance and connected to SDGs. An important facet of this contribution is the delineation of a comprehensive framework for CE knowledge data management and prioritised actions. This provides the necessary scaffolding for organisations to empower their workforce and effectively utilise digital technologies for environmentally conscious, lean, socially responsible, and economically feasible decision-making. As the world grapples with escalating environmental crises and economic disparities, our research underscores the pressing need for CE integration and the achievement of SDGs. The insights gained from this study aim to steer academic discourse, inform policy, and guide organisational practice towards a more sustainable and resilient future. We envisage that this extensive exploration of CE would inspire further investigations, policy formulations, and business strategies that echo the principles of sustainability and circularity.

As with any research, our research has several limitations: however, these offer opportunities for future research. First, our study did not include several journals, as we considered only articles ranked 3* and above in the AJG journal rankings table (except *The Journal of Cleaner Production*). These may have limited our findings and our ability to identify more insightful information. As such, future studies should consider articles published from various sources, including non-academic reports such as PwC, Ellen MacArthur Foundation, *The Conversation* and Forbes.

Also, our search strategy may have omitted articles that may have been relevant to the topic due to: (1) the use of Boolean operators and the chosen search strings; (2) filters used that returned articles from the business and management discipline only; (3) human error during the coding process. Therefore, future studies should consider multidisciplinary literature in their search strategy, since CE has been identified as multidisciplinary. The bulk of the literature considered is huge, and the analysis of so much information was a hefty task. This could have led to the omission of certain important themes that may have been missed in the present review. Hence, future researchers are encouraged to conduct similar reviews using more advanced tools to further identify new themes. The themes identified are all particularly important, and individual reviews may be conducted for each of them. The boundaries of the identified themes are still fuzzy; hence, future researchers may be encouraged to quantify each of these research themes. The review thus provides us with some valuable information and leaves us with important questions for future explorations. The current review does not quantify the research priorities linked to research propositions and pathways, which can be validated in the future by conducting empirical studies with business practitioners, policymakers, and academic experts. In this context, Delphi-style focus groups and interviews should be conducted with each stakeholder to capture their views on the research propositions and their significance. The data collected during these sessions can be analysed using multi-criteria decision-making methods to help quantify the importance of the research priorities, which will help to strategise future research pathways in the area. The insights from the empirical study will help to take stock of industry practitioners' viewpoints on the research propositions and agendas developed through comprehensive academic reviews, thus bridging the gap between theoretical perspectives (academic literature) and business as well as societal needs.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to the size of the dataset.

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