A big picture of circular economy in organizations

A focus on North American Researchers1

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1 It should be noted that this is a review of the scientific literature on the subject and does not represent the formalized position of the RRECQ. This literature review was carried out with the help of artificial intelligence tools.

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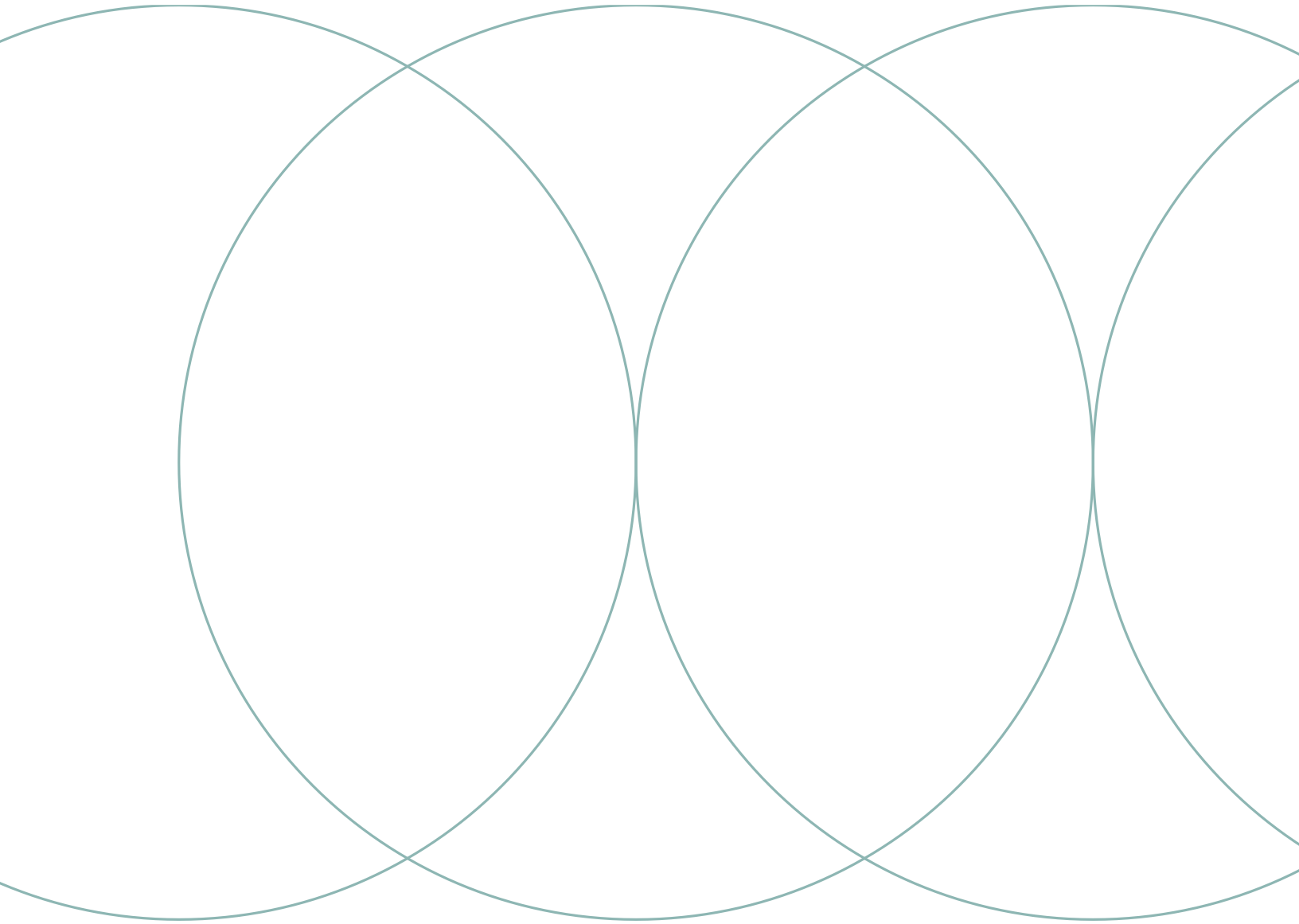

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Abstract:

The circular economy (CE) has emerged as a significant framework for fostering sustainable development. This systematic literature review paints a broad picture of CE principles. From this more global picture, the North American perspective helps clarify certain aspects that are affected by specific institutional contexts. By examining a wide range of organizational contexts, this study provides a detailed overview of the integration of CE practices. It explores the various drivers and barriers to CE adoption, highlighting the role of technological, policy, financial, cultural and social factors. The review also delves into sector-specific strategies and practices, illustrating the unique approaches to CE in different industries and their impact on organizational performance across economic, environmental and social dimensions. Through this comprehensive analysis, the research sheds light on the diverse pathways organizations are taking toward integrating CE principles. The findings offer valuable insights into the challenges and opportunities that this sustainable economic model presents, contributing to a deeper understanding of CE's pivotal role in advancing sustainable development within the organizational sphere. Additionally, the study proposes directions for future research, policy development and the enhancement of practices as the field continues to evolve.

I.
Introduction

The circular economy (CE) represents a paradigm shift in the approach to economic development, sustainability and resource management [1]. Unlike the traditional linear economic model, which follows a "*take-make-dispose*" trajectory [2], CE promotes regenerative design aimed at minimizing waste [3], circulating resources and maximizing value throughout the entire lifecycle of products and services. This model diverges significantly from linear methodology by emphasizing the reuse, repair, refurbishment and recycling of materials and products [4]. The linear model, deeply ingrained in most of today's economic activities, operates on the assumption that resources are abundant, available and cheap to dispose [5]. This approach has led to significant environmental degradation, resource depletion and increased greenhouse gas emissions, contributing to global challenges, such as climate change and biodiversity loss [6, 7].

In contrast, CE is premised on three core principles designed to benefit **businesses**, **society** and the **environment**: designing out waste and pollution, keeping products and materials in use, and regenerating natural systems [8]. By embedding these principles into economic activities, CE aims to create a system that is restorative and regenerative by design [9]. This holistic approach not only addresses the sustainability challenges posed by the linear model but also offers a pathway to innovative business models, economic opportunities and a more resilient system that can operate within the planet's ecological limits [10].

A alleged fundamental aim of CE is to decouple economic growth from resource consumption and environmental impact [11]. This decoupling is crucial in a world where the finite nature of physical resources contrasts sharply with the continuous pursuit of economic expansion. CE advocates for a system where growth is not achieved at the environment's expense but through smarter, more efficient use of resources, innovation in product design and the adoption of business models that support product-as-a-service concepts, among other strategies [12]. By doing so, CE not only contributes to sustainability but also offers a competitive edge to businesses that adapt to its principles through cost savings, enhanced brand reputation, and alignment with emerging regulatory requirements and consumer preferences for sustainable products [13].

Moreover, CE's role in promoting sustainability transcends environmental benefits, encompassing economic and social dimensions [14]. Economically, it encourages the creation of new jobs and industries centred on circular practices, such as recycling, remanufacturing and product-service systems. Socially, it fosters a shift toward more sustainable consumption patterns, equitable access to resources and the development of communities around shared use and circular practices [15]. Thus, the circular economy is not just an environmental imperative but a holistic strategy for sustainable development that aligns economic activities with the planet's ecological boundaries and societal needs [13].

In embracing CE, organizations across the spectrum are pivotal to driving this transition. Their role in adopting and integrating circular principles into operations, strategies and value chains is crucial for realizing the systemic change required for a sustainable future [16]. However, the integration of CE principles across diverse organizational contexts remains a significantly under-researched area, revealing a conspicuous gap in the existing literature [17-19]. This study is motivated by the urgent need to bridge this gap, recognizing the pivotal role organizations play in driving the transition toward a more sustainable and circular economic model [8, 20]. While the theoretical foundations of CE are well established, there is a profound need to explore and understand how different types of organizations—spanning manufacturing, services, public

sector, cooperative and non-governmental organizations (NGOs)—implement and are impacted by CE principles in practice. This exploration is crucial for identifying actionable pathways and strategies that organizations can adopt to advance their sustainability agendas effectively.

Aligned with the research goals, this study aims to explore the adoption and implementation of CE across various organizational contexts, highlighting the challenges, opportunities and impacts of such practices on a path towards a more sustainable and circular world.

The subsequent sections are organized to provide a comprehensive understanding of this study. **Section II** outlines the methodology employed in this systematic literature review, detailing the search strategy, the study selection process and the use of AI tools to facilitate the research. **Section III** presents the research goals and questions that guided the investigation, establishing a framework for exploring the various dimensions of CE within organizations. **Sections IV** and **V** delve into the core concepts of CE integration within different organizational types, exploring the motivations, benefits, drivers and barriers to adoption. **Section VI** examines sector-specific approaches and strategies, highlighting unique challenges and opportunities across diverse industries. **Section VII** identifies the critical success factors and enablers for effective CE implementation. **Section VIII** analyzes the influence of organizational size and geographical location on CE adoption and effectiveness. Finally, **Section IX** proposes future research directions to advance the understanding and implementation of CE within organizations, paving the way for a more sustainable and circular future. **Section X** concludes the study.

II.
Methodology

This study uses the widely recognized systematic literature review (SLR) methodology proposed by Okoli and Schabram [21]. It includes four phases: Planning, Selection, Extraction, and Execution (Fig. 1). In addition, this study used a human-centred, artificial intelligence-based (HCAI) approach to facilitate the SLR process. The main idea of HCAI systems is to be able to use AI-based tools to improve human performance while preserving human values [22]. In other words, HCAI systems simultaneously pursue two objectives: empowering the human user and ensuring compliance with ethical considerations [23]. Human empowerment means that AI-based systems are designed with properties that allow humans to stay in control for the sake of safety and self-determination [22].

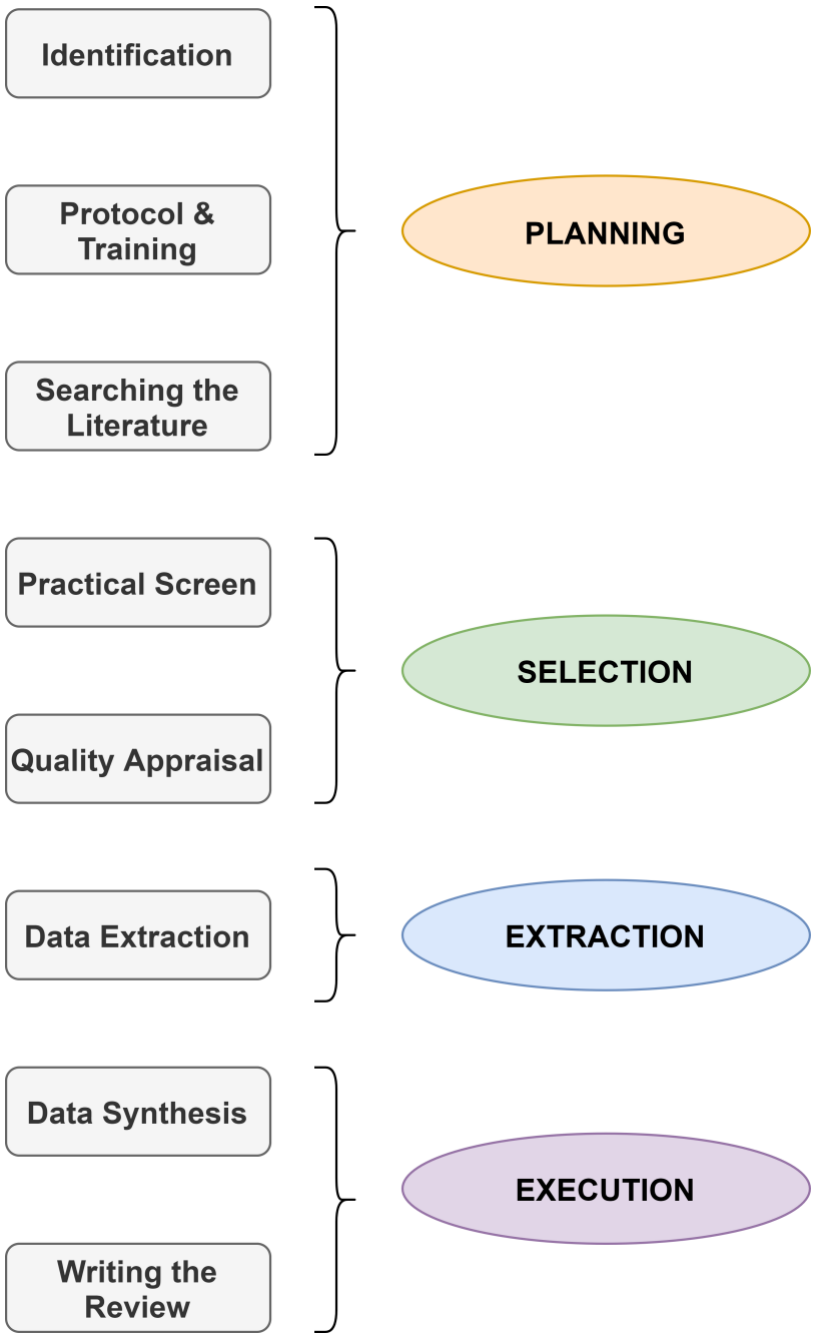

Figure 1. Systematic literature review process

Table 1 presents the details of these steps and the roles of the AI tools used in each step.

Table 1.
SLR steps and roles of AI tools

Step (S)	Description	Role of AI tools
Identification (S1)	Involve the purpose, goals, title, keywords, and research questions	Suggest, refine, and select the research title, keywords, outline, research questions
Protocol & Training (S2)	Concern about the review process protocol if there are multiple reviewers	Support the collaboration of reviewers
Literature Search (S3)	Explore various databases to locate relevant papers	Search for papers related to specific keywords or research questions
Practical Screen (S4)	Identify which studies meet the review criteria for inclusion	Prioritize relevant titles or/and abstracts with keyword highlight
Quality Appraisal (S5)	Establish exclusion criteria to assess the quality of studies and determine their eligibility for inclusion	Semi-automated assessment based on the quality assessment questions or keywords
Data Extraction (S6)	Extract information and content from selected research papers	Automatically extract key information and results from papers according to the research questions
Data Synthesis (S7)	Combine the extracted facts from studies conducted in selected research papers	Summarize and synthesize key findings of papers, suggest the conclusions, research gaps
Writing the Review (S8)	Focus on presenting the results of the review in a systematic and organized manner	Draft initial sections, paraphrase the text of the report

Search Strategy

This study gathered research studies from the Scopus database. The choice of this database took into account its scope and relevance in academia. Researchers commonly use this database because it provides access to high-quality, peer-reviewed papers and other academic resources.

A tripartite grouping of keywords was employed in the titles, keywords or abstracts of potential articles to ensure a comprehensive and systematic inclusion of pertinent literature in this review. This grouping ties in directly with the study's main research questions and aims.

The first group of keywords focused on the core theme of the review: ***circular economy***. It included the following terms: *Circular Economy, Circular Model, Circular Resource, Closed Loop Economy, Closed Loop Supply Chain, Closed Material Loops, Cradle to Cradle, Industrial Ecology, Industrial Ecosystems, Regenerative Design, Renewable Resources*.

The second group aimed at organization concepts: *Business, Company, Corporate, Enterprise, Firm, Institution, Organization*.

The third group was designed to ensure that this review covers as many different aspects as possible of the circular economy: *Adoption, Ambivalence, Barriers, Catalyst, Circular Business, Circular Design, Clean Energy, Circular Practices, Constraint, Drivers, Eco-Design, Environmental Analysis, Environmental Impact, Framework, Green Design, Implementation, Indicator, Innovation, Lifecycle Analysis, Lifecycle Assessment, Managerial Barrier, Material Flow, Material Cost Flow, Metric, Model, Obstacle, Perspective, Policy, Recycling, Regulatory, Regulations, Remanufacturing, Reuse, Responsible Purchasing, Social Impact, Social Implications, Society, Strategies, Sustainability, Sustainable Design, Sustainable Production, Technological Barrier, Technology, Transition, Waste Management, Waste Minimization, Waste Reduction*.

Study Selection

The circular economy topic has recently attracted considerable attention. Therefore, many literature review papers have been published in this context. In view of the large number of works listed, this report is based on two groups of texts, one comprising 100 literature research reviews (see Appendix A), and a second group of 70 texts that go into greater detail on certain aspects and present a more representative portrait of North American work (see Appendix A).

The inclusion of the first group in this study serves to provide a comprehensive and global context for understanding the circular economy and its implementation within organizations. These texts were contributed by a diverse group of researchers, both from within and outside North America. These papers collectively address a broader spectrum of topics related to the circular economy.

The second consists of individual papers authored by North American researchers. Each paper delves into one or several specific facets of the circular economy in organizations.

Group 1 provided a comprehensive overview of the circular economy, akin to sketching the broad outlines of a picture. By contrast, Group 2 focused on intricately detailing the inner aspects of the picture.

The selection process for the literature review papers was as follows:

- Timeframe filtering: The search results were filtered to include only papers published between 2014 and 2024, ensuring the inclusion of the most recent and relevant research on CE.
- Relevance screening: The abstracts and titles of the remaining papers were carefully reviewed to assess their relevance to the study's objectives. Papers that did not primarily focus on CE or did not provide information that could be used to answer the research questions will be excluded.

The selection process for the North American texts was as follows:

- Studies published in the last five years between 2020 and 2024
- Studies published in conferences and journals
- Studies with authors from North America
- The full text of the study is available.

All selected research articles were saved in *EndNote*, a reference management software for scholarly publications.

Practical & Full-Text Screening

Once the initial search is completed, the identified studies must be screened based on their titles and abstracts to eliminate irrelevant entries. This process is crucial in narrowing the search results to a manageable number of studies for further assessment. For this step, a quality assessment should be conducted. Since this study aims to explore the literature related to a circular economy in an organizational context, the two assessment questions are defined as follows.

- **QA1:** Does the title or abstract contain keywords from the keyword groups?
- **QA2:** Is the study targeted as a “circular economy for the organizational context?”

This process was conducted in the *Covidence* platform with a keyword highlight function and using the *Typeset* platform. It resulted in 100 records for the first group and 70 records for the second group, with titles and abstracts that satisfied the criteria for QA1 and QA2.

AI Tools

This study uses the following AI tools to support the SLR process: *Covidence*, *ChatGPT, ClaudeAI, Google Gemini, Typeset (Scispace)*, and *Elicit*.

- *Covidence*: This tool supports the practical screening step.
- *ChatGPT, ClaudeAI, Google Gemini*: These tools support refining the keywords, research questions, search queries, summarization and data synthesis.
- *Typeset*: This tool supports quality appraisal, full-text screening and data extraction.
- *Elicit*: This tool supports data extraction.

III.
Research questions

The journey toward integrating and maximizing CE within organizations necessitates a structured exploration of how CE principles are adopted and implemented and their resultant impacts across various sectors. This section delineates the research goals, questions (RQs), and sub-research questions (sub-RQs) and elucidates the intricate relationships among them, laying the foundation for a comprehensive investigation into the multifaceted domain of CE in organizational contexts.

The study was driven by five overarching research goals (Fig. 2), each aligned with specific research questions and sub-questions to facilitate targeted exploration:

1. **Goal #1:** To Synthesize and Understand Circular Economy Integration Across Organizational Types:

   - **RQ1**: Integration and Core Concepts of Circular Economy in Organizations
     - RQ1.1: How do different types of organizations integrate CE principles into their operations?
     - RQ1.2: What are the core concepts and principles of CE implementation in these organizations?

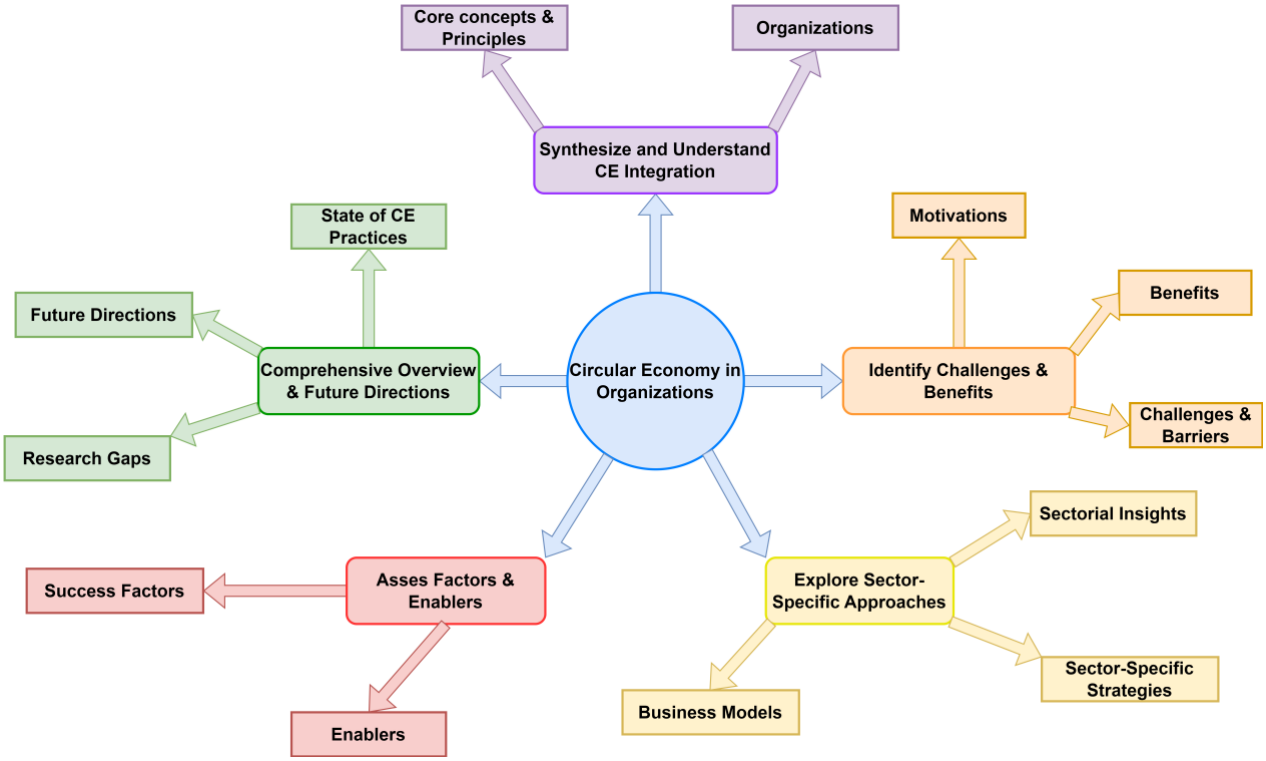

Figure 2. Research goals

2. **Goal #2:** To Identify Challenges, Benefits and Key Themes in CE Implementation:

- **RQ2**: Drivers, Motivations and Benefits for Adopting Circular Economy
  - RQ2.1: What motivates organizations to adopt CE practices, and what benefits do they perceive?
  - RQ2.2: What are the key drivers and barriers faced by organizations in adopting CE practices?

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3. **Goal #3:** To Explore Sector-Specific Approaches and Determine Critical Strategies or Models:

- **RQ3**: Strategies, Models and Innovations for Sector-Specific in Circular Economy
  - RQ3.1: How do CE practices vary across sectors, and what strategies are employed?
  - RQ3.2: What key CE business models and innovations are implemented?

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4. **Goal #4:** To Assess the Factors and Enablers:

- **RQ4**: Critical Success Factors
  - What are the critical success factors and enablers for effective CE implementation?

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5. **Goal #5:** To Provide a Comprehensive Overview and Future Directions:

- **RQ5**: Impact Assessment and Organizational Influences
  - RQ5.1: What impact does CE implementation have on organizational performance?
  - RQ5.2: How does size influence CE adoption and effectiveness?

- **RQ6**: Future Research Needs and Directions
  - What are the future research needs and directions for advancing CE in organizations?

The research questions and sub-questions are interconnected, forming a cohesive framework (Fig. 3) that guides the exploration of CE in organizations:

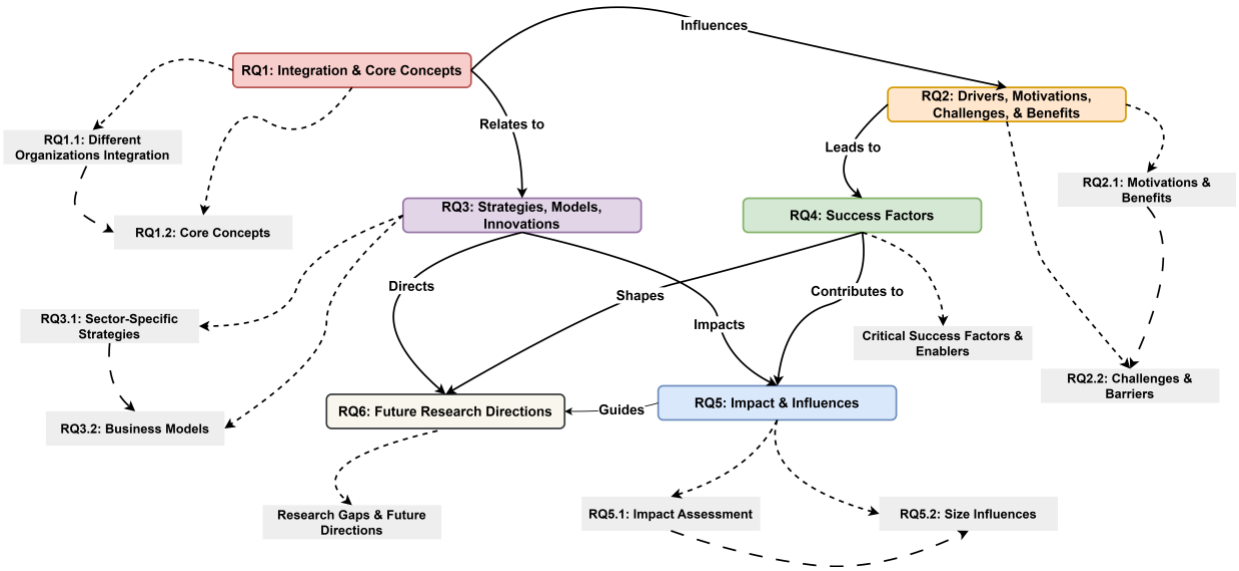


Figure 3. Research Questions and Sub-Research Questions

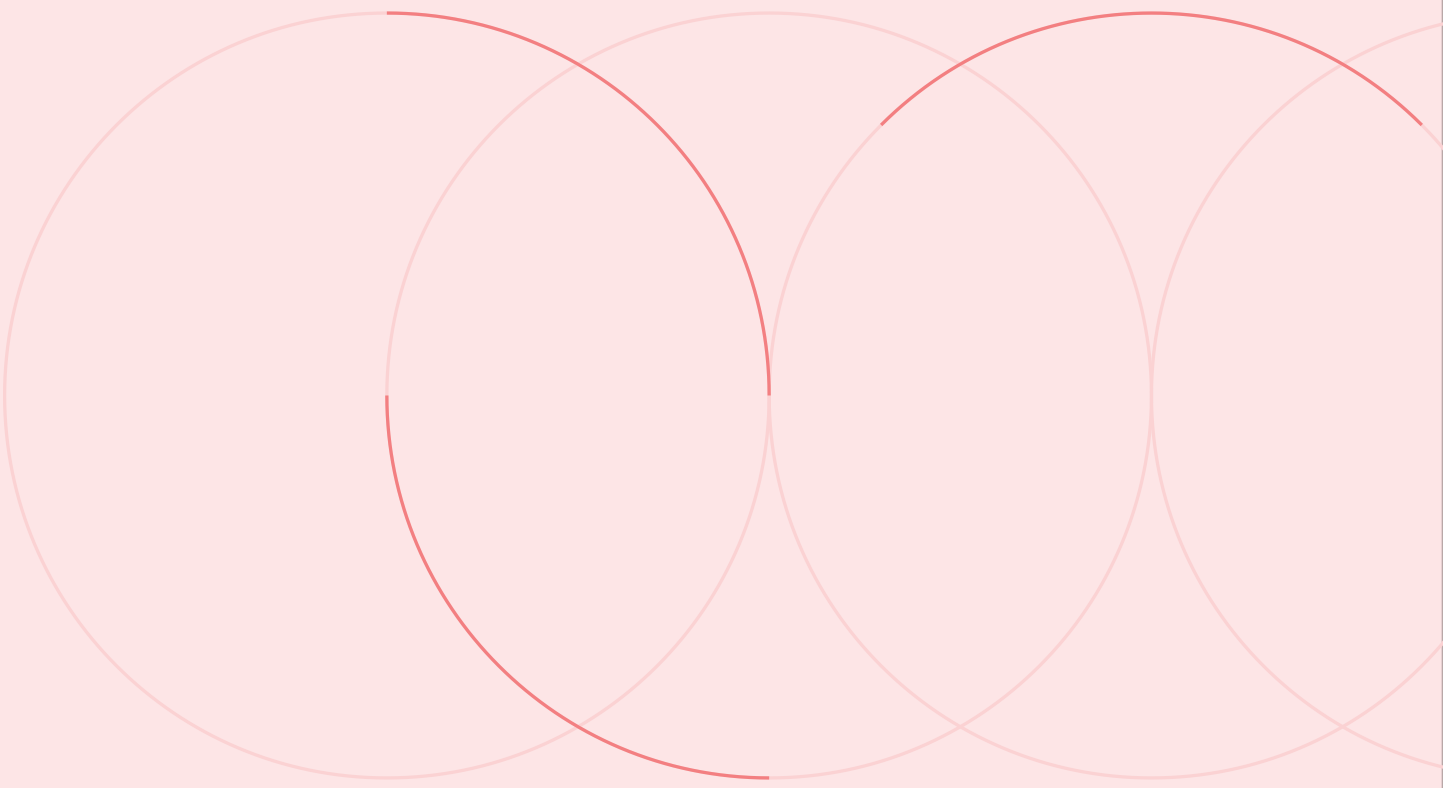
- **RQ1 to RQ2:** Understanding how organizations integrate CE principles (RQ1) illuminates the motivations and benefits driving their adoption (RQ2), indicating a foundational relationship between integration strategies and adoption incentives.
- **RQ1 to RQ3:** The core concepts of CE (RQ1) underpin the strategic and innovative approaches to CE (RQ3), suggesting that a deep understanding of CE principles is essential for developing effective strategies.
- **RQ2 to RQ4:** The motivations and barriers identified (RQ2) naturally lead to an exploration of broader challenges and success factors (RQ4), as understanding what drives or hinders adoption is crucial for identifying how to overcome obstacles and capitalize on enablers.
- **RQ3 to RQ5:** The strategies and models employed (RQ3) directly influence the assessment of CE's impacts on organizations (RQ5), demonstrating that strategic choices have tangible outcomes on organizational performance and sustainability.
- **RQ4 to RQ5:** Identifying success factors (RQ4) enhances understanding of CE's impacts (RQ5), as these factors directly affect the effectiveness and sustainability of CE practices.
- **RQ5 to RQ6:** Observations on impacts and organizational influences (RQ5) guide the identification of future research needs (RQ6), as the current state of CE practices highlights areas requiring further investigation and development.

Each set of sub-questions within the broader RQs reflects specific aspects of exploring CE in organizations:

- **RQ1.1 and RQ1.2** demonstrate the necessity of understanding both the integration strategies and the core principles of CE for a holistic view of CE adoption.

- **RQ2.1 and RQ2.2** highlight the interplay between positive incentives and the challenges of adopting CE practices, emphasizing that benefits and drivers are closely linked to overcoming barriers.
- **RQ3.1 and RQ3.2** suggest that sector-specific strategies are integral to the broader implementation of CE, indicating the importance of tailored approaches within diverse organizational contexts.
- **RQ5.1 and RQ5.2** show that the impacts of CE practices are significantly influenced by organizational characteristics, such as size and location, stressing the need for context-sensitive approaches to CE adoption.

IV.
Integration and core concepts of circular economy in organizations



A. Integration of Circular Economy Principles in Different Organizational Operations

The circular economy model offers a paradigm shift from the traditional linear economy, focusing on resource efficiency and waste minimization. Various types of organizations—manufacturing firms, service providers, public sectors and nongovernmental organizations (NGOs)—have adopted distinct approaches to integrating CE principles into their operations. This subsection elucidates these strategies by drawing on evidence from the literature.

Private Enterprise – Manufacturing Firms

Manufacturing firms are pivotal in the transition toward a circular economy. These organizations have adopted practices aimed at reducing resource consumption and waste generation. Strategies include improving process efficiencies to use less energy, adopting renewable energy sources [24, 25] and redesigning products to use fewer materials and last longer [26-30]. Additionally, manufacturing firms have embraced recycling and remanufacturing processes, turning waste materials back into raw materials or new products, thereby closing the loop in their production cycles [31-39].

Manufacturing organizations redesign their products, processes and supply chains to minimize waste and maximize resource efficiency. They focus on strategies such as recycling, remanufacturing, repair, reuse and closed-loop systems [25, 40]. They may use recycled materials as inputs [38, 39], adopt remanufacturing processes, design products for longer use and ease of recycling [27-30] and establish systems for product return and recycling [27].

Organizations across diverse sectors are adopting various strategies and practices to integrate circular economy principles into their business operations and supply chains. Manufacturing companies are integrating circularity by focusing on eco-design, cleaner production [41, 42], waste reduction and enabling the recovery of end-of-life products through strategies like reuse, remanufacturing and recycling [43-45]. For instance, they are designing products for durability, recyclability and ease of disassembly to enable circular strategies after use [46]. Companies also increasingly adopt circular business models [47], such as product-service systems [48, 49],

sharing platforms [9, 50] and product life extension through repair, maintenance and remanufacturing [45, 48, 51]. Additionally, manufacturing organizations are building closed-loop and reverse logistics to enable end-of-life value recovery through strategies like reuse, remanufacturing and recycling [44, 52-55].

The concerted efforts of manufacturing firms to integrate circular economy principles into their operations reveal a multifaceted strategy aimed at achieving sustainable development. This approach not only mitigates the environmental footprint associated with manufacturing activities but also heralds a new era of economic growth that is increasingly decoupled from finite resource consumption. Through their pioneering practices, these organizations set a precedent for the industry, showcasing the viability and benefits of a circular economy model. The adoption of such principles signifies a profound transformation within the manufacturing sector, highlighting its pivotal role in fostering innovation, enhancing competitiveness and contributing to a more sustainable and resilient future.

Private Enterprise – Service Providers

Service organizations often aim to extend the lifespan of products and resources [27, 33, 56]. They implement strategies such as product-as-a-service models, repair and maintenance services [33, 56], sharing platforms and leasing [27, 56]. By retaining ownership of products and offering them services, service providers can ensure efficient resource utilization, facilitate repair and reuse, and manage end-of-life processes effectively [27, 33, 56].

Additionally, service companies have approached CE integration by offering products as services, a model known as product-service systems (PSS) [27, 33, 56]. This approach extends the lifecycle of products through leasing, repair services and maintenance [27, 33], reducing the need for new products and thus minimizing waste. Service providers also focus on long-lasting product design and repair services to enhance product longevity and promote sustainable consumption patterns [33, 56].

Furthermore, service organizations are integrating circular economy principles by offering product-oriented services, pay-per-use or sharing models, repair and maintenance services, and takeback programs [56]. This allows them to extend product lifetimes and enable circular resource flows [47]. Moreover, service companies are leveraging connectivity technologies, such as the Internet of Things (IoT), to enable circular models through real-time monitoring, transparency in material flows and data-driven decision making [57, 58].

Public Sectors

Public sector entities play a critical role in facilitating CE adoption through policy and regulation [59, 60]. These organizations manage waste by promoting recycling and sustainable consumption. Public sectors enforce regulations encouraging recycling, sustainable product design and the implementation of circular economy practices within businesses and communities [6, 59, 60]. Furthermore, they are involved in managing solid waste as a resource, aiming to recover and reuse materials, which includes systematic source separation and composting organic waste [31, 32].

Additionally, public sector organizations are integrating circular economy principles through policymaking, public procurement focused on sustainability, and supporting infrastructure development for material collection and waste management [59, 60]. For instance, regulations, incentives and infrastructure for waste collection and recycling are being implemented [59, 60]. Additionally, sustainable public procurement strategies are being adopted to stimulate circular production and consumption across value chains [5, 61]. They may enforce regulations that promote recycling, sustainable procurement and waste management [59, 60], implement deposit return schemes [62], and create incentives for sustainable practices.

In combining these approaches, public sector entities emerge as pivotal actors in the shift toward a more sustainable and resilient economy. By setting the stage for circular practices through policy and regulation, driving the market toward sustainable options through procurement and establishing the necessary infrastructure to support these transitions, public sector entities are crucial in fostering an environment where circular economy principles can thrive and induce systemic change throughout the economy [9, 63]. Through these concerted efforts, public sector organizations help pave the way for a regenerative economic model that is both environmentally sustainable and economically viable.

Cooperative organizations

Cooperative organizations (co-ops), especially within the agri-food sector, are exemplars of sustainability in action, actively embedding CE principles into their operations with a significant commitment to sustainability [64]. They champion these principles through their community-oriented, resource-efficient operations, emphasizing collaborative partnerships to foster a supportive ecosystem that encourages the sharing of knowledge and resources [64]. Their comprehensive approach to sustainability spans the entire value chain, from valorizing agricultural waste by transforming it into eco-friendly products to promoting sustainable consumption and innovative waste management, thereby contributing to the development of

circular societies and regional economic growth [65].They maximize the efficiency of resources, particularly through the innovative use of biomass, and focus on minimizing waste, underscoring their dedication to promoting sustainable agricultural practices and upcycling waste materials [65]. This not only exhibits innovation in waste management but also supports marginalized communities, contributing to local economic development and enhancing the inclusivity of CE practices.

In their journey toward supply chain sustainability, co-ops leverage the power of strategic partnerships and cooperative ventures to enhance resource circularity and spur innovation [66]. Sustainable procurement, circular design principles, and an ambition for zero-waste production reflect their strong commitment to CE principles and environmental stewardship. Moreover, co-ops engage consumers in their sustainability journey, implementing eco-labelling and green marketing strategies to foster greater awareness and adoption of CE values [66].

The concept of mutualisation is central to co-op operations, embodying CE's focus on shared responsibility and efficient resource use through collective action, such as shared machinery use and partnerships for waste reduction [64]. This approach not only reduces environmental impact but also showcases co-ops' commitment to fostering environments that support circular practices and sustainable development, underscoring their pivotal role in the sustainability landscape [49].

Non-Governmental Organizations

Non-governmental organizations (NGOs) play a complementary role by building awareness, educating the public and businesses, conducting advocacy campaigns and supporting grassroots community initiatives related to CE adoption [26, 35]. For example, NGOs build community engagement around recycling, upcycling and waste reduction programs. They also collaborate with businesses and other organizations to promote CE adoption through campaigns and initiatives [27, 67].

Additionally, NGOs contribute to CE integration by engaging with the public and businesses to promote circular economy principles [26, 35]. Through education and community-based initiatives, NGOs work to reduce product waste, support recycling efforts and collaborate with companies to improve environmental outcomes. These organizations also play a crucial role in raising awareness about the benefits of circular economy practices and facilitating the transition through advocacy and support for sustainable practices [26, 35].

Furthermore, NGOs frequently play a supportive role in promoting circular economy principles through advocacy, education and community engagement [34, 41]. They may raise awareness about the benefits of a circular economy, support community-based recycling and upcycling

initiatives [34, 41], and advocate for environmental sustainability and fair labour practices in recycling efforts [60].

In summary, NGOs frequently assume a supportive and catalytic role in advancing circular economy principles. Their activities range from advocacy and education to direct community engagement, all aimed at fostering a sustainable transformation in societal attitudes and practices toward resource use and waste management. Through persistent efforts, NGOs are vital in promoting a holistic approach to the circular economy, ensuring that its principles are widely understood, accepted and implemented [28, 38, 63].

Table 2 presents a summary focusing on how different organizations integrate circular economy principles into their operations.

Table 2.
How different organizations integrate circular economy principles into their operations

Organization Type	Integration Approaches	Operational Focus	Example Practices	Enabling Factors	Outcomes
Private Enterprise – Manufacturing Sector	Eco-design, cleaner production, recycling, remanufacturing, closed-loop supply chains, reverse logistics	Product design, production processes, supply chain management	Designing for durability, recyclability, disassembly; adopting circular business models like product-service systems; establishing take-back programs and reverse logistics	Digitization, partnerships, sustainable sourcing, investments in technology for reverse logistics, data analytics	Reduced material waste and carbon emissions; cost savings from material efficiency; new revenue streams
Private Enterprise – Service Provider Sector	Product-oriented services, sharing models, repair/maintenance, take-back programs	Business models, customer engagement, product lifecycle extension	Providing products through leasing and pay-per-use models; offering repair, maintenance, upgrade services; implementing product take-back	Connectivity technologies like IoT, digitized platforms	Increased product use, higher value from existing products; avoided waste by extending lifecycles
Public Sector	Policy and regulation on recycling, waste management, sustainable design; sustainable public procurement; infrastructure development	Waste management, sustainable practices adoption, government operations	Mandates and incentives for recycling, circular design; preferential procurement of sustainably produced goods and services; building recycling and waste management infrastructure	Multi-stakeholder collaboration, public-private partnerships	Transition to circular economy; new businesses and jobs focused on circularity; resource conservation
Co-ops (Agri-Food Sector)	Valorizing agricultural waste, resource efficiency, upcycling, community development	Comprehensive sustainability across the value chain; focus on biomass use, waste minimization, circular design, and	Sustainable procurement, eco-design, shared machinery, and partnerships for waste reduction; engaging consumers with eco-labeling and green marketing	Collaborative partnerships, mutualisation and community engagement, strategic partnerships for innovation	Growth of circular economies and regions, inclusive CE adoption, elevated CE awareness, shared resource impact reduction

		zero-waste production			
NGOs	Awareness building, advocacy campaigns, community initiatives	Education, stakeholder engagement, grassroots projects	Workshops on sustainability; collaborations with businesses on eco-innovation; community recycling and upcycling drives	Partnerships, government support, volunteer networks	Cultural shift; public buy-in for circular transition; demonstration of circular principles

B. Core Concepts and Principles of Implementing Circular Economy in Organizations

CE is a regenerative and restorative approach that aims to minimize waste and maximize resource utilization by creating closed-loop systems [9, 68]. In organizational contexts, CE principles guide the design, production and consumption of products and services to eliminate waste, optimize resource use, and retain value throughout the lifecycle.

Core Concepts

- **Waste Elimination:** CE emphasizes designing products and processes that minimize waste generation and pollution from the outset [50, 66, 69]. This involves strategies such as reducing resource consumption, recycling materials and using renewable energy sources [55, 70].
- **Resource Utilization:** Organizations optimize resource use by designing products for longevity, maintaining and repairing them, and reusing or recycling materials at the end of their life [14, 19, 38, 49, 71]. This approach maximizes the value extracted from resources and minimizes the need for virgin materials [72, 73].

- **Value Retention:** CE encourages organizations to preserve the value of products and materials throughout their lifecycle by implementing circular strategies, such as reuse, remanufacturing and recycling [28, 45, 74, 75]. This ensures that resources are kept in use for as long as possible, thus reducing waste and resource depletion [76, 77].

Principles

- **Design for Circularity:** Incorporating circularity principles into product design is crucial for facilitating disassembly, reuse and recycling at the end of a product's life [24, 33, 78, 79]. This includes considerations such as modularity, durability and the use of recyclable materials [80, 81].
- **Product Longevity:** Extending the lifespan of products through maintenance, repair and remanufacturing is a key principle of CE [14, 71, 82]. Organizations implement strategies such as product-life extension, refurbishment and upgradability to keep products in use for as long as possible [83].
- **Material Recovery:** At the end of a product's life, organizations prioritize recovering and reusing materials to minimize waste and resource depletion [45, 76, 84]. This involves implementing effective waste management systems, recycling processes and material recovery technologies [85].
- **Sustainability Integration:** Successful CE implementation requires aligning organizational values, operations and decision-making processes with circular economy principles to promote environmental responsibility and sustainable development [18, 86, 87].
- **Collaboration and Innovation:** Fostering partnerships and innovation across the value chain is essential for developing new circular solutions, business models, and technological advancements that support CE [36, 88-90]. This collaborative approach facilitates the sharing of resources, knowledge and best practices [91, 92].

Implementation Strategies

Organizations implement CE principles through various strategies:

- **Product-as-a-Service Models:** Instead of selling products, organizations offer access to products through leasing, renting or sharing models [27, 49, 57, 88]. This promotes reuse, reduces waste and aligns with the principle of retaining value and extending product life.

- **Circular Supply Chains:** Establishing closed-loop supply chains [93] that collect, process and reuse materials is crucial for creating circular material flows [63, 94, 95]. This involves collaboration with suppliers, reverse logistics and effective waste management systems.
- **Resource Recovery and Processing:** Investing in technologies and processes to recover and recycle materials from waste streams is a key aspect of CE implementation [85, 96]. This includes strategies such as selective demolition, disassembly and open-loop recycling [97].
- **Education and Awareness:** Engaging stakeholders, including employees, customers and the broader community, in circular economy initiatives is essential [97-99]. Organizations promote sustainable consumption and production practices through education and awareness campaigns.
- **Data and Analytics:** Utilizing data and analytics to track resource consumption, identify waste reduction opportunities, and improve circularity performance is crucial for effective CE implementation [100, 101]. Technologies such as IoT, AI and data science support this effort [100].

By integrating these core concepts and principles (Fig. 4), organizations can navigate the transition to a circular economy model. This transition is essential for minimizing environmental impacts, conserving resources and fostering sustainable value chains. It is a pathway to achieving economic, environmental and social benefits that align with the broader goals of sustainability [43, 102].

V.
Motivations, benefits, drivers and barriers for adopting a circular economy

A. Motivations and Benefits

The transition toward a circular economy is driven by a multitude of motivations and benefits that underscore the strategic shift in organizational practices. An extensive literature review revealed a consistent theme in the rationale for organizations to adopt circular economy principles.

Environmental Motivations and Benefits

***Reducing waste and pollution*:** A fundamental driver for organizations to adopt circular economy practices is the significant environmental costs associated with waste generation and pollution. Landfilling and incineration lead to greenhouse gas emissions and water and soil contamination. By prioritizing reuse and recycling over disposal, organizations can diminish their impact on the planet. This aligns with increasing global environmental regulations that promote waste reduction and recycling [14, 26, 29, 31, 34, 37, 41, 68, 103, 104].

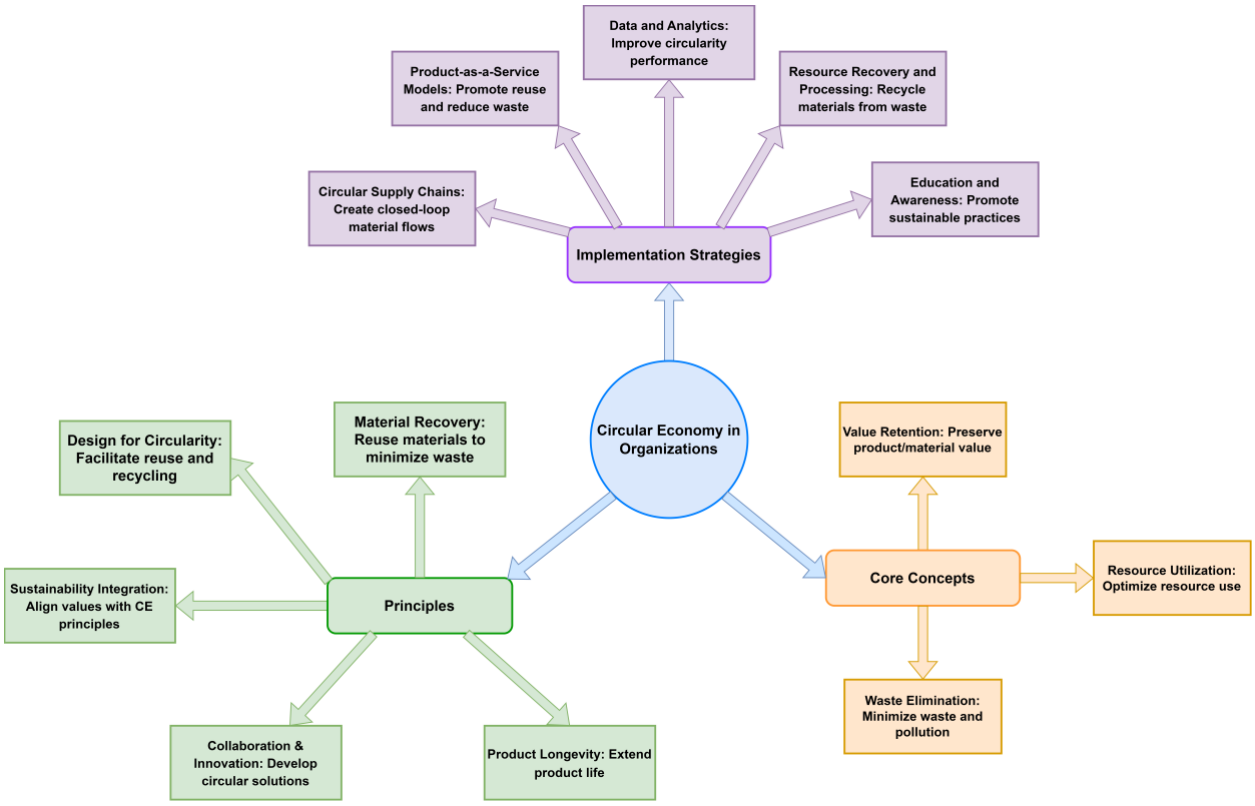


Figure 4. Core concepts, principles and implementation strategies

***Enhancing sustainability and resource efficiency*:** Circular design, remanufacturing, product-as-a-service and other innovations enable far more efficient utilization of resources by maximizing product utility, reuse potential and recapture of materials [8, 38, 45, 57, 103]. Rather than following a linear take-make-dispose model, circular principles allow for the decoupling of economic value creation from finite resource consumption, thereby supporting sustainable growth [45, 103].

Mitigating supply chain risks: Circular practices reduce reliance on virgin natural resources and buffer organizations against disruptions or scarcity of material supplies [8, 26, 38, 45, 105, 106]. By substituting recycled materials into production processes and recovering end-of-life products, companies can develop closed-loop systems to improve supply security [38, 47, 105, 106]. This enhances organizational resilience while supporting environmental sustainability.

Economic Motivations and Benefits

Cost savings: Reusing materials multiple times and extracting further value from waste and by-products significantly cut costs for organizations. It reduces raw material purchases and waste disposal fees. Recycled content also tends to be more affordable than virgin resources. Other economic benefits include operational efficiencies from optimized resource flows, energy savings from lightweight redesigns and lower investment needs through long-lasting products. These savings multiply over the product lifecycle [8, 28, 35, 36, 39, 63, 67, 96, 107, 108].

Creating new business opportunities: The circular economy unleashes innovative business models that profit from the refurbishment, remanufacturing and recycling of components and products. Organizations find opportunities in consulting and technology/services centered around the secondary materials market and the sharing economy. Collaboration bridges gaps between competitors to create circular supply chains. Circular models like product-as-a-service, sharing platforms and product life extension services are opening fresh revenue streams for organizations through sustainable offerings. Pay-per-use, performance-based contracts and other novel value propositions allow companies to tap into new markets and customer segments [8, 55, 88].

Gaining competitive advantage: Organizations gain first-mover benefits by proactively embracing circular transformation. They attract environmentally-minded customers and retain existing loyal customers through sustainable offerings and transparency [109]. Circular product design and new services capture a larger market share. Partnerships consolidate industry leadership. While the initial costs of transitioning operations may be greater, forward thinking has strategic long-term advantages over late adopters [14, 28, 29, 36, 37, 48, 104].

Compliance and Brand Image

Compliance with regulations: Governments are implementing extensive policy and regulatory frameworks to promote a circular transition. Noncompliance can result in heavy penalties for organizations. Regulations cover standards for recycled content percentage, bans/taxes on single-use plastic, extended producer responsibility protocols and mandates on waste reduction/recycling targets. Straying from these compliance requirements increases financial and legal risks. Proactive action avoids future operational restrictions [26, 33, 34, 36, 38, 39, 41, 103].

Improving brand reputation and customer loyalty: Companies that publicly commit to and proactively implement circular practices can positively differentiate themselves and build trust among increasingly climate-conscious consumers [14, 29, 34, 35, 37, 41, 48]. Studies indicate that environmentally friendly brands foster greater loyalty, advocacy and willingness to pay premium prices among customers [110]. Circular economy integration also boosts employee motivation and investor confidence in forward-looking companies [35, 104].

Positive impacts on employees: Working in a company that prioritizes sustainability and environmental protection can greatly enhance job satisfaction and instill a sense of pride in one's work. Employees may feel more motivated and engaged when they know their efforts contribute to positive environmental and social impacts [10, 111]. Moreover, the circular economy can create new job opportunities in areas such as recycling, remanufacturing and maintenance, providing employees with job security and the chance to develop new skills and knowledge [10]. As companies adopt innovative and sustainable practices, employees can gain exposure to cutting-edge technologies and processes, making their work more fulfilling and rewarding [4, 112]. The transition to a circular economy may also lead to a positive shift in work culture, as employees collaborate to find creative solutions for minimizing waste and optimizing resource use. However, the shift to a circular economy can also present challenges for employees. They may need to adapt to new roles and responsibilities, requiring re-skilling and learning new processes. Initially, there might be some uncertainty and resistance to change, but with effective leadership and a clear vision, employees can embrace and drive the transition toward a more sustainable future [4]. In the long run, the circular economy can offer increased job security as businesses become more resilient to resource scarcity and regulatory changes. Additionally, the focus on reducing toxic materials and promoting a cleaner environment can lead to healthier workplaces, benefiting employees' well-being [101]. Overall, the circular economy presents a unique opportunity for employees to be part of a transformative movement that not only benefits the environment but also offers personal and professional growth, motivation and a sense of purpose in their work [111].

Social Motivations and Benefits

Meeting customer demand: Meeting customer demand for sustainability is a major motivator, as consumers increasingly prefer eco-friendly offerings. Studies show rising demand, especially among younger demographics, for products and services from companies committed to environmental stewardship [8, 14, 28, 34-39, 63, 68, 96, 113]. Circular models, such as clothing rentals, reusable packaging and recycled materials, resonate strongly with green-minded consumers.

Supporting sustainable development and social responsibility: Adopting CE practices aligns organizations with broader sustainable development goals, such as promoting resource efficiency, curbing pollution and fostering green employment [18, 71]. At their core, CE practices promote resource efficiency by keeping materials and products in circulation for as long as possible. This reduces the extraction of virgin resources and the generation of waste, thereby lowering the environmental impact of economic activities. Organizations that implement circular models curb pollution across production, consumption and waste management processes. Beyond environmental benefits, CE practices underscore an organization's commitment to social responsibility [114] through the creation of new green jobs and skills. The repair, refurbishment, remanufacturing and recycling activities within CE require green technical skills and employment opportunities compared to the traditional linear model of take-make-dispose. Organizations that adopt CE practices often directly contribute to green job creation, as well as skill development, in their supply chains and local communities [18, 71]. By driving both environmental and social progress, CE practices underscore an organization's commitment to sustainability and social responsibility. The adoption of CE practices resonates with multiple stakeholders who value corporate social responsibility. Employees derive motivation from working for organizations that "walk the walk" on sustainability. Customers increasingly favor brands with ethical and green credentials. Investors seek organizations that manage risks and find opportunities in the transition to a sustainable economy. Communities benefit from CE organizations that create local green jobs and support circular innovations.

In summary, the shift toward circular economy practices is underpinned by a complex interplay of drivers, encompassing environmental stewardship, economic incentives, competitive dynamics, regulatory compliance and social responsibility. Collectively, these drivers not only compel organizations to reconsider their production and consumption patterns but also provide a compelling value proposition to innovate, build resilience and thrive in a rapidly changing economic landscape. This multifaceted motivation aligns with global priorities for sustainable development, signalling a strategic shift in organizational practices that promises both immediate and long-term benefits.

B. Barriers

Organizations' adoption of circular economy practices faces various barriers. These barriers, which span economic, knowledge-related, organizational, technological, policy-driven and consumer behaviour factors, often interconnect with and compound the difficulty of transitioning to circular systems. It is important to note that these barriers are not mutually exclusive, and organizations may encounter multiple barriers concurrently.

Economic Barriers

The adoption of CE practices is often obstructed by a range of economic barriers, with the limitation of initial costs and investments necessary for the transition being among the most important [26, 37]. These financial considerations are further exacerbated by a lack of economic incentives that could offset the expenses of adopting CE practices. Organizations frequently prioritize economic sustainability, which may overshadow ecological concerns, creating tension between financial viability and environmental responsibility.

The complexity associated with establishing reverse supply chains presents another economic hurdle. These supply chains demand new logistics and processes, which can limit managerial control and complicate the flow of materials and products. Such complexity can result in insufficient returns from closed-loop systems, especially when the market for recycled or reused outputs is underdeveloped or non-existent [37, 48, 96, 115].

Moreover, the process of redesigning products and systems to align with CE principles is not only intricate and costly but is also fraught with the risk of unintended adverse consequences. These can range from disruptions in current operations to the need for significant changes in product design and lifecycle management. Organizations often find it challenging to measure and communicate the long-term economic benefits of these transformations, making it difficult to justify the initial investment and operational shifts required for a circular transition [43, 48, 94, 113, 116].

In summary, the economic barriers to CE adoption are multifaceted, involving direct costs, market limitations and the complex interplay between financial and ecological goals. To navigate these challenges, organizations must carefully consider the full

spectrum of economic impacts and seek innovative strategies to leverage CE practices as a pathway to sustainable profitability.

Knowledge and Expertise Barriers

The transition toward CE frameworks is significantly hindered by a pervasive deficit in the requisite knowledge and expertise among organizational personnel. A proficient understanding of CE principles is crucial, yet such expertise is often scarce within the workforce. This knowledge gap extends to the intricacies of sustainable supply chain management—a cornerstone of CE—which demands a nuanced approach to the procurement, use and reuse of materials that diverges from traditional linear models [8, 37, 39, 45, 117-119].

The challenge is not solely in acquiring raw knowledge; the application of CE principles is context specific, requiring tailored skills to navigate industry-specific complexities. For instance, ensuring the retention of product quality while implementing CE measures is a delicate balancing act. It involves assessing the lifecycle impacts of products, redesigning for durability and potentially remanufacturing or refurbishing to extend product life without compromising the end-user experience [64, 79, 115, 120-122].

Additionally, the management of sustainable supply chains under a CE model requires a sophisticated understanding of logistics, including reverse logistics for product returns, recycling or remanufacturing. These processes necessitate systematic coordination, which is often at odds with established business practices. Moreover, the integration of CE measures often calls for systemic organizational change, necessitating change management skills that ensure smooth transition and adoption across all levels of the organization [64, 120-122].

The elevation in expertise is not limited to technical skills but also encompasses a shift in mindset. A CE approach involves a move away from the “take-make-dispose” paradigm to one that sees waste as a design flaw and recognizes the value retention opportunities in product end-of-life. This philosophical shift requires education and training in circular design principles, systems thinking and material flows, which are not commonly included in traditional business education or professional development programs [66, 79, 101, 121-125].

In summary, overcoming knowledge and expertise barriers demands significant investment in education and professional development. Organizations must cultivate a culture of continuous learning and innovation to equip their workforce with the skills necessary to implement and sustain CE initiatives. This training should not only focus on technical competencies but also on fostering a holistic understanding of the principles and strategic imperatives of the circular economy.

Organizational Barriers

In the context of implementing CE practices, organizations frequently encounter a range of internal barriers that can impede progress. One of the most pervasive of these is resistance to change, which presents itself across various levels of an organization [43, 48, 56, 63, 67, 70, 126, 127]. This resistance is often underpinned by cultural inertia—a reluctance to deviate from established norms and routines that have historically driven the organization's operations [67, 79, 84, 125].

This challenge is further exacerbated by a lack of structured decision-making processes within some organizations [113, 128]. Without clear frameworks for decision making, it becomes difficult to effectively evaluate and implement new strategies that align with CE principles. This lack of structure can lead to indecision and missed opportunities to pursue sustainable practices.

Cultural resistance to change is not only a barrier within individual organizations but also manifests within the broader supply chains [43]. The complexity of supply chain dynamics means that introducing CE practices requires cooperation, trust and transparency across a network of partners and stakeholders [71, 129]. However, existing relationships and processes within supply chains can be deeply entrenched, making it challenging to foster the necessary collaboration for a successful transition to circular models.

This resistance to change is often compounded by a general lack of knowledge or access to appropriate technology, as explained above [130]. Without the necessary understanding of CE processes or the tools to implement them, organizations and their supply chains are ill equipped to make the necessary shifts in practice. The knowledge gap can lead to skepticism or a lack of buy-in from key stakeholders, further entrenching resistance to change.

In summary, organizational barriers to adopting CE practices are multifaceted and deeply rooted. They range from an internal culture of resistance to change through inadequate decision-making frameworks to the complexities of supply chain collaboration. Addressing these barriers requires a concerted effort to foster a culture of adaptability, establish structured processes for decision making, enhance knowledge and technology access and build robust partnerships within supply chains. The transition to a circular economy can be effectively realized only by addressing these organizational challenges.

Technological Barriers

CE practices are also obstructed by significant technological barriers that organizations must navigate. One of the most prominent challenges lies in the lack of existing infrastructure to support new circular processes [8, 27, 39, 41, 74, 105, 106]. This infrastructure is essential for collecting, processing and repurposing materials, yet many organizations find their current facilities and systems inadequate for these tasks.

In addition to infrastructure deficits, the financial burden associated with adopting new technologies is a substantial barrier for many organizations [113, 116]. The high costs of new machinery and equipment necessary for circular operations can be prohibitive, particularly for smaller enterprises or those with already thin profit margins. Such investments are often required upfront, while the economic benefits of CE practices may accrue more slowly over time, further complicating investment decisions [76, 116, 131].

Moreover, transitioning from existing linear processes to circular ones involves a complexity that cannot be overstated. Changing established procedures requires not only financial investment but also a rethinking of operations and supply chain logistics. The need for new technologies is a recurring theme in discussing technological barriers [75]. Innovations in material recycling, product design for disassembly and remanufacturing are all areas where technological advancements could facilitate a smoother transition to CE. However, the development and dissemination of these technologies are often slow. Introducing new technologies often necessitates significant alterations to workflow, staff training, and potentially even organizational structure. This complexity can serve as a deterrent to change, especially when the outcomes of such transformations are uncertain [78, 84, 132].

A holistic approach is necessary to overcome technological hurdles in implementing CE. This includes significant investment in supportive infrastructure, innovation to reduce the financial impact of acquiring new machinery and strategic efforts to modify existing operational processes. Accelerating the development and integration of innovative technologies is critical, requiring organizations to adapt their operations to meet CE principles proactively. A strong technological base is essential for effectively overcoming these barriers and enabling a seamless transition to more sustainable, circular practices.

Policy and Regulatory Barriers

The advancement of CE practices often encounters a complex web of policy and regulatory barriers that can significantly slow its momentum. One of the foundational issues is the lack of comprehensive regulations and guidelines that clearly outline the path for CE adoption [97, 112]. Without these directives, organizations are left to navigate an uncertain landscape, unsure of the requirements and standards for circular processes.

Further complicating the transition is the inadequate legal basis for extended producer responsibility (EPR) [72]. EPR is a policy approach that requires producers to be responsible for the entire lifecycle of their products, including takeback, recycling and final disposal. The absence of robust legal frameworks around EPR leaves organizations unclear about their obligations and the mechanisms for ensuring product safety throughout a product's lifecycle, which includes any second-use applications.

This uncertainty can lead to industry hesitance, particularly with concerns that the original producers should manage second-use or recycling initiatives to avoid issues related to safety and quality [72]. If producers believe that only they have the expertise and capability to handle their products responsibly post-consumer use, this can limit the development of a more collaborative and open CE market where various stakeholders can contribute to extending product lifecycles [19].

Another hurdle is the lack of government aid and support. Financial incentives, tax breaks, grants and technical assistance are examples of government aid that can ease the transition to CE practices. Without such support, the economic burden of adopting new circular processes may be too great for many organizations, particularly small and medium-sized enterprises (SMEs) [7, 133-135].

In summary, policy and regulatory barriers present significant challenges to the implementation of CE. The absence of clear guidelines, insufficient legal frameworks for EPR, industry hesitance and a lack of government support all act as deterrents to organizations considering the shift to circular models. Addressing these barriers will require proactive efforts from policymakers to create an environment that not only encourages but also supports organizations in adopting CE practices.

Consumer Behaviour Barriers

The shift toward CE necessitates the active participation of all stakeholders, including consumers whose behaviour presents distinct barriers to adopting circular practices. A primary obstacle is the lack of consumer awareness of the impacts of their purchasing choices and a prevailing preference for new, non-green options [29, 136]. Consumers often default to the linear “take-make-dispose” model, not out of preference but due to a lack of understanding of the circular economy’s principles and the benefits of recycled or refurbished products.

The awareness issue [136] is compounded by the absence of systems or rules to facilitate the adoption of circular practices [68], which can indicate a broader societal challenge, including consumer behaviour. When consumers are not demanding circular products, it becomes a Herculean task to shift the entire value chain toward circularity [80].

Further complicating matters are the reluctance of suppliers, distributors and sellers to engage in return logistics, which is crucial for closing the loop in circular practices [9]. This reluctance can be influenced by consumers’ disinterest in participating in such systems, whether due to inconvenience or a lack of incentives.

A significant consumer behaviour barrier [29, 33, 105] is the low preference for refurbished and reused products. This is often driven by the perception that such products are inferior to new items, a myth that needs to be dispelled through education and the demonstration of the quality and reliability of refurbished goods. Moreover, the current market reflects a lack of customer demand for products with circular aspects [114]. Without consumer interest, businesses are less motivated to prioritize circular economy practices in their strategies and operations.

In addressing these barriers, it is essential to make circular choices convenient and attractive to consumers, integrating such options into existing purchasing habits. There is a need for improved infrastructure to facilitate recycling and reuse, making the process as frictionless as possible. To appeal to the diverse interests of consumers, targeted segmentation and marketing strategies are necessary. This approach acknowledges that a one-size-fits-all strategy cannot achieve mass market demand for eco-friendly products.

Overcoming the entrenched social and cultural narratives that celebrate consumption and ownership requires concerted efforts from governments, businesses and thought leaders. Advocacy and educational campaigns are vital in changing the conversation around consumption and guiding it toward sustainability.

In conclusion, addressing consumer behaviour barriers involves a multi-pronged strategy: raising awareness, ensuring convenience, altering perceptions and incentivising circular choices. This multi-stakeholder effort is paramount in enabling the essential shift toward a sustainable and circular economy.

Overarching Challenges

Beyond these categories, organizations grapple with additional challenges. One such challenge concerns occupational health risks and the associated costs of protective equipment for waste pickers. Integrating informal waste management systems into formalized circular systems is not only a matter of logistics but also of ensuring the safety and dignity of all individuals involved. The complexity of safely incorporating these workers into circular supply chains represents a significant overarching challenge [27, 45].

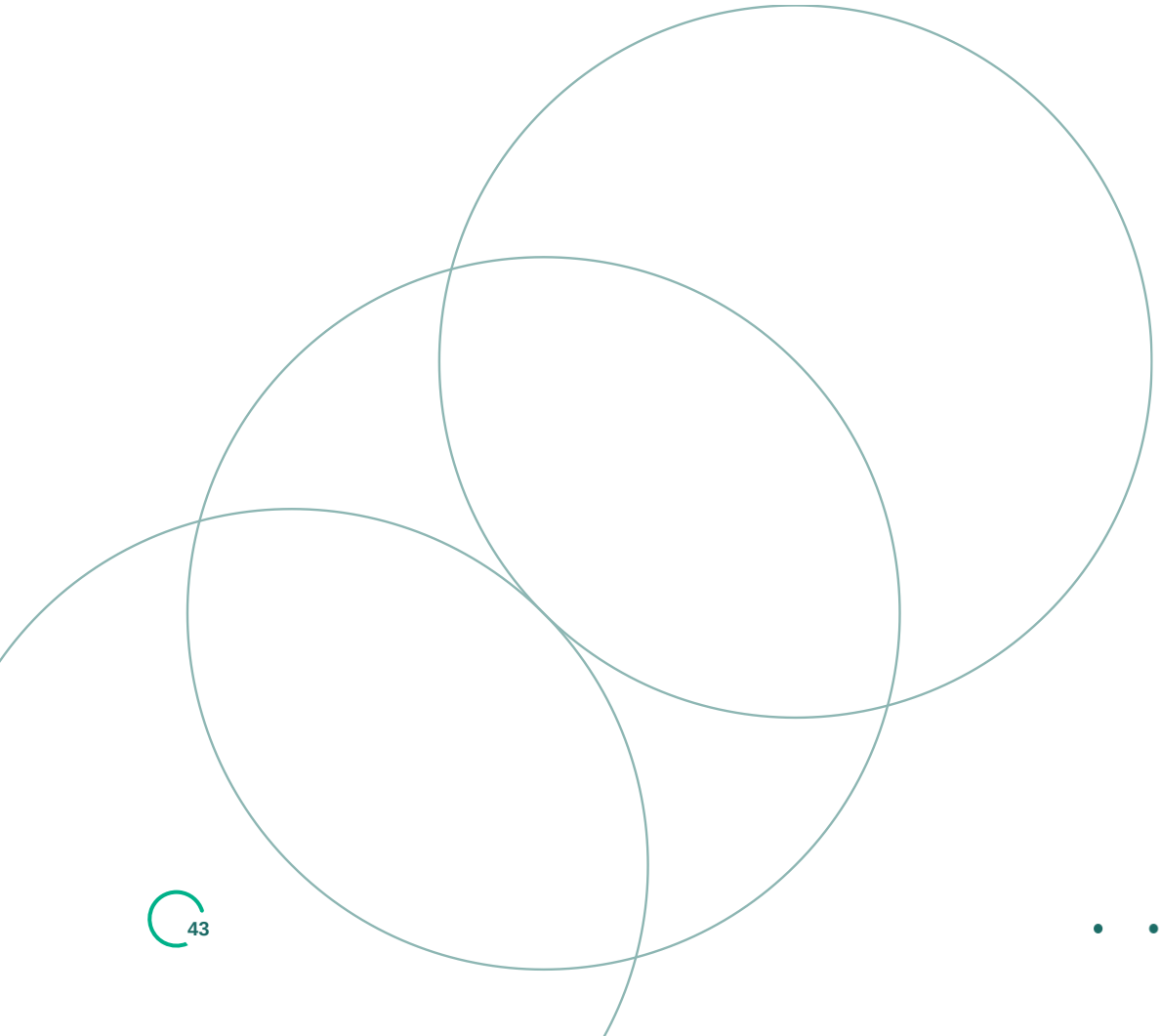
Another pressing issue is the environmental impact of material selection [18]. This raises questions about the capacity to select appropriate materials and design truly circular products. The materials science and product design challenges in ensuring that products are both circular by design and have minimal environmental impact form a considerable barrier. This challenge spreads across industries and touches on the need for innovation and systemic change in how products are conceptualized from the outset.

Additionally, the study highlights the cultural, economic and structural roadblocks that micro-social entrepreneurs encounter. These challenges reveal a wider canvas of cultural norms and structural issues that can inhibit the growth and impact of grassroots initiatives aimed at driving circularity from the bottom up. Such barriers can profoundly affect the capacity of these entrepreneurs to innovate and implement sustainable solutions at the local level.

Moreover, the barriers to effective supply chain coordination, as discussed in [88, 137], point to systemic challenges that cut across the entire network of production and consumption. These coordination issues are indicative of the complexities involved in aligning multiple stakeholders with diverse objectives and capabilities, which are essential for a seamless and sustainable circular supply chain. These cross-cutting, system-wide challenges highlight the need for an integrated approach to managing and facilitating supply chain dynamics in the pursuit of a fully realized circular economy.

It is imperative to recognize that these barriers do not exist in isolation; they often intersect, creating a complex web that organizations must navigate. For instance, a lack of knowledge within an organization may coincide with internal resistance to change, each exacerbating the other [37, 105]. To overcome these barriers, organizations are advised to prioritize education and training, fostering a culture that values circular principles and understands the benefits and processes involved. Additionally, building new partnerships and collaborations can address knowledge gaps and facilitate shared learning. Advocacy for supportive policies and regulations that incentivize CE practices can also play a pivotal role in overcoming these obstacles.

While the barriers to adopting circular economy practices are significant and varied, they are not insurmountable. A combination of strategic investment, educational initiatives, policy advocacy and stakeholder collaboration is essential to facilitate this crucial transition toward sustainability.



VI.
Strategies, models and innovations across diffrent sectors

A. Analysis of Circular Economy Practices Across Different Sectors

An analysis of CE practices across different sectors reveals a multifaceted approach tailored to the unique characteristics and needs of each industry [61, 118, 138]. Different sectors prioritize different aspects of circularity based on their unique operations and products. While some focus on material reuse and recycling, others emphasize resource efficiency, production optimization and infrastructure development [34, 139]. Table 3 presents a brief summary of how circular economy practices vary across different sectors.

Table 3.

How circular economy practices vary across different sectors

Sector	Key Materials/Resources Used	Types of Waste Generated	Specific Practices Employed	Drivers for Adoption	Barriers to Implementation	Key Stakeholders Involved	Impacts and Benefits	Studies
Construction	Building materials (concrete, steel, wood, etc.)	Construction, demolition waste	Implementing modular designs for easy reuse, using sustainable and recyclable materials, designing buildings for easy disassembly	Lower costs, reduced environmental impact	Technical challenges, lack of regulation, industry standard	Architects, engineers, contractors, construction companies	Reduced virgin material use, less landfill waste, lower environmental impact, cost savings	[31, 32, 35, 45, 46, 97, 107, 115, 136, 138, 140-143]
Agriculture	Water, soil, crops, seeds, fertilizers	Crop residues, manure, food waste, soil degradation	Using organic waste as compost, crop rotation and sustainable water management, regenerative farming practices	Food security, soil health, reduce pollution	Transition costs, lack of infrastructure, lack of awareness	Farmers, agricultural companies, consumers	Enhanced nutrient cycles, less waste	[26, 28, 30, 35, 55, 144, 145]
Electronics	Metals, rare earth elements	E-waste	Take-back schemes for recycling, refurbishing old devices, designing products for easy repair and recycling	Recover rare materials, lower costs, consumer demand	Technological complexity, rapid obsolescence	Electronics companies, retailers, consumers	Resource conservation, material recovery, reduced landfill	[33, 74, 94, 103, 146, 147]
Fashion/Textiles	Textiles (cotton, synthetic fibers, etc.)	Textile waste, water pollution	Clothing recycling, recycling garments, and sustainable materials emphasis, offering clothing rental services	Maintain competitiveness, consumer awareness, environmental impact	Fast fashion trends, cost of sustainable materials	Brands, manufacturers, recyclers, consumers	Reduced waste, material reuse	[14, 18, 20, 117, 148, 149]
Automotive	Metals, plastics, rubber, glass	End-of-life vehicles, manufacturing waste	Remanufacturing parts for reuse, refurbishing vehicles to extend their lifecycle	Retain value, reduce costs	High initial investment, customer acceptance	Manufacturers, suppliers, dealerships, consumers	Resource efficiency, component reuse	[127, 150]
Retail	Various consumer goods	Product returns, packaging	Implementing take-back programs, selling	Customer demand, sustainability	Logistical challenges,	Retailers, disposal companies	Reduced waste, product lifespan extension	[37, 68, 71, 77, 131]

Sector	Key Materials/Resources Used	Types of Waste Generated	Specific Practices Employed	Drivers for Adoption	Barriers to Implementation	Key Stakeholders Involved	Impacts and Benefits	Studies
		waste, unsold goods	refurbished or second-hand products	goals, new revenue	consumer behavior			
Packaging	Plastics, paper, glass	Packaging waste	Compostable packaging, waste collection, designing sustainable packaging options	Lower costs, Consumer preferences, environmental regulations	Cost of alternative materials, infrastructure	Packaging manufacturers, brand owners, consumers	Reduced environmental impact, waste minimization	[35, 63, 103, 113, 145]
Energy	Fossil fuels, nuclear fuels, wind, sun	Emissions, petrochemical waste	Investing in renewable energy sources, Solar, wind power, energy management	Lower emissions, energy security, climate policies,	Technological and financial barriers, policy uncertainty	Energy providers, government, consumers	Lower emissions, sustainable resource use	[39, 86, 151]
Tourism	Water, energy, food	Food waste, operational waste (plastics, paper, etc.)	Reducing food waste through better planning and donation, implementing energy-saving measures in facilities	Competitiveness, cost savings	Lack of infrastructure, consumer behavior	Hotels, restaurants, tour operators, tourists, governments	Lower environmental impact, cost reductions	[40, 152]
Waste Management	Garbage, refuse	Landfill emissions, leachate	Cooperative models, applying AI, enhancing recycling processes, promoting waste reduction strategies	Environmental regulations, public awareness	Collection infrastructure, negative perceptions, Technological limitations	Municipal authorities, reprocessors, communities, consumers	Resource recovery, waste minimization, decrease in landfill use,	[88, 100, 120, 153]
Water	Freshwater	Wastewater, polluted runoff	Treating and reusing wastewater, implementing greywater systems	Water scarcity, environmental impact	Treatment costs, infrastructure costs, health concerns	Governments, utilities, agriculture, households	Conservation of water resources, reduced pollution	[120]
Mining	Minerals, metals, energy	Mine tailings, waste rock, water pollution	Reprocessing mine tailings, improving resource extraction efficiency	Resource depletion, regulatory compliance	Economic feasibility, technological challenges	Mining companies, regulators, local communities	Resource efficiency, reduced environmental impact	[120, 154, 155]
Aerospace	Metals, composites, fuels	Manufacturing scrap, end-of-life aircraft	Remanufacturing aircraft components for reuse, recycling materials from	Cost of raw materials, environmental regulations	Meeting quality standards, proprietary data	Aircraft manufacturers, airlines,	Reduced material usage, minimized waste, cost savings	[84]

Sector	Key Materials/Resources Used	Types of Waste Generated	Specific Practices Employed	Drivers for Adoption	Barriers to Implementation	Key Stakeholders Involved	Impacts and Benefits	Studies
			decommissioned aircraft			maintenance companies		
Marine	Metals, composites, fuels	Ship-breaking waste, operational waste (oils, etc.)	Remanufacturing parts for ships, recycling materials from decommissioned ships	Environmental regulations, operational costs	Meeting quality standards, technical feasibility	Ship owners, maintenance providers, regulatory bodies	Improved resource efficiency, cost savings	[84]
Equipment and Machinery	Metals, plastics, electronic components	Broken parts, end-of-life equipment, manufacturing scrap	Remanufacturing components for reuse, regular maintenance to extend equipment life	Cost efficiency, resource scarcity	High initial investment, technical expertise, proprietary designs	Manufacturers, service providers	Extended product lifetimes, reduced waste	[51, 156]
Chemical	Fossil fuels, biomass, chemicals	Production byproducts, chemical waste	Recycling chemical containers, reprocessing by-products into raw materials	Regulatory compliance, cost savings	Investments required, Safety concerns, purity requirements	Chemical companies, waste handlers, regulatory agencies	Resource recovery, hazard reduction, reduced extraction	[153]
Forestry	Wood, plant residues	Sawmill leftovers, harvesting waste	Utilizing sawmill residues for biomass energy, recycling wood waste into particleboard or other products	Sustainable forestry, maximize resource use, new revenues	Limited local demand, low-value products	Forestry companies, mills, energy producers	Reduced residuals, new products	[157]
Education	Paper, electronics, various materials for educational activities	Educational waste, e-waste	Integrating circular economy concepts into curricula, promoting recycling and sustainability on campus	Awareness raising, future workforce preparation	Overloaded curricula, assessments, resource availability	Educational institutions, students, staff	CE-literate graduates, cultural change	[99]
Health Sciences	Pharmaceuticals, medical supplies, water	Medical waste, expired drugs	Proper disposal of medical waste, recycling of medical materials, drug take-back programs	Patient safety, environmental regulations	Strict regulations, risk of contamination	Researchers, healthcare providers, pharmaceutical companies, patients, waste	Reduction in medical waste, safe disposal of pharmaceuticals, resource conservation	[99]

Sector	Key Materials/Resources Used	Types of Waste Generated	Specific Practices Employed	Drivers for Adoption	Barriers to Implementation	Key Stakeholders Involved	Impacts and Benefits	Studies
						management firms		

B. Key Circular Economy Strategies, Business Models, and Innovations Implemented

This section elaborates on the pivotal CE strategies, business models, and innovations currently being implemented across various organizational contexts. These approaches are instrumental in propelling the transition toward a more sustainable, efficient and circular economy.

Circular Economy Strategies in Organizations

- **Design for Longevity:** Organizations increasingly design products with durability and easy maintenance in mind. This approach not only extends the product's life but also supports the reduction of resource consumption [26, 33, 158]. By focusing on product longevity, companies can reduce the overall environmental impact associated with manufacturing new products [35, 96];
- **Take-back and Recycling Programs:** Take-back programs serve as a critical strategy for recycling or refurbishing products at the end of their lifecycle [35, 90]. These programs ensure that materials are responsibly managed and reintegrated into the production cycle, thus minimizing waste [14, 34, 39]. Coupled with this is the process of recycling and upcycling, where materials are repurposed to create new products, further supporting the circular economy;
- **Resource Sharing and Utilization:** The transition to a circular economy has seen a rise in resource-sharing initiatives, such as car-sharing programs, that reduce the need for individual ownership [26, 35, 45]. Additionally, organizations are developing sharing platforms to maximize goods usage, ensuring that products are used more efficiently and by a larger number of users [28, 29, 107, 156, 159, 160];
- **Renewable Energy and Sustainable Materials:** Utilizing renewable energy and sustainable materials in production is a cornerstone of circular economy strategies [40, 99, 161]. Organizations are making concerted efforts to source renewable or easier-to-recycle materials, reducing their dependence on finite resources and lowering their carbon footprint [68, 107];

- **Waste Management and Resource Recovery:** Effective waste management systems are essential for reclaiming materials from products that have reached the end of their useful life. By reusing materials to make new products and creating systems to facilitate this process, organizations can significantly reduce their environmental impact [14, 33];
- **Resource Loop Management:** Managing resource loops is key to a circular economy. This involves closing resource loops by recycling materials back into production, slowing loops by making products last longer, and narrowing loops by using fewer resources in production [8].

Circular Business Models and Innovations

- **Product-as-a-Service (PaaS):** PaaS models have emerged as a transformative business model in which customers lease or rent products rather than purchase them outright [20, 27, 31, 37]. This model encourages product reuse and extends the lifecycle of products, aligning with the principles of a circular economy [14, 37];
- **Waste-as-a-Resource approach:** In this model, waste from one industry becomes a valuable input for another, creating industrial symbiosis networks [39, 85, 93, 95, 120, 129, 162, 163]. This model promotes collaboration among different sectors and enables the creation of new value streams from previously discarded materials;
- **Service and Maintenance Models:** Services focused on repair and maintenance help extend the life of products. By offering repair or updated services, organizations can ensure that products remain functional for longer periods, thus reducing the demand for new products [33, 38].
- **Sharing Economy Platforms:** Organizations are implementing sharing economy platforms that facilitate access to products without the need for ownership. This not only reduces waste but also promotes a more efficient use of resources [14, 80, 108, 164];
- **Remanufacturing and Refurbishing:** Remanufacturing and refurbishing are crucial strategies that extend product life. By refurbishing old products, organizations can offer consumers “like-new” products without the environmental impact associated with producing new items [107];
- **Reverse Logistics and Closed-Loop Supply Chains:** Reverse logistics systems are crucial for managing product returns and recycling. Innovations in this area enable organizations to efficiently return used products to the production cycle [37]. Closed-loop supply chains go a step further by recycling all materials, thereby minimizing waste and environmental impact.

Advanced Circular Economy Innovations

- **Digital and Technological Advancements:** The adoption of blockchain and IoT technologies has enhanced resource tracking and supply chain transparency [105, 130]. These technologies play an essential role in the circular economy by providing accurate data for optimizing resource use [105] and they are being leveraged to track and optimize resource flows, improve traceability, and facilitate data-driven decision-making [4, 27, 50, 57, 58, 63, 77, 81, 82, 100, 105, 122, 150, 165]. Digital twins and product tagging also contribute to better resource management [57];
- **Sustainable Material Innovations:** Nature-based solutions harness renewable materials and energy sources, contributing to a more sustainable production process and reducing reliance on non-renewable resources [14]. For example, as described in the study [166], renewable raw materials, such as biomass, are being used as alternatives to fossil-based resources in various industrial applications. This shift is evident in the production of adhesives, textiles, cosmetics and cleaning agents, as well as in coatings, paints, printing inks, crop protection, lubricants and dietary supplements. By replacing fossil resources with biomass, which is replenished through natural processes, industries are able to decrease their dependence on finite non-renewable resources, thereby moving toward a more sustainable and environmentally friendly production model. The development of new materials that are biodegradable or more easily recycled is a significant innovation within the circular economy. Such materials help to reduce waste and facilitate the recycling process [27, 31, 39];
- **Innovative Recycling Technologies:** New recycling processes and technologies are being developed to improve material recovery and support the transition to CE. These innovations enable more efficient recycling and repurposing of materials, thereby reducing dependency on virgin resources [9, 24, 126].

The integration of circular economy strategies into organizational practices is pivotal for sustainable development. Through the design of durable products, innovative recycling programs, an emphasis on resource sharing, and the use of renewable materials, organizations are paving the way toward a more sustainable future. Business models, such as product-as-a-service and sharing economy platforms, are not only innovative but also instrumental in reducing waste and promoting the efficient use of resources. Furthermore, technological advancements and sustainable material innovations are enhancing the capacity of organizations to implement effective circular economy strategies. Collectively, these efforts

contribute significantly to the reduction of environmental impact, preservation of resources and creation of economic value within the framework of the circular economy.

VII.
Critical Success Factors

As organizations increasingly recognize the benefits of adopting CE principles, identifying the critical success factors and enablers becomes crucial for effective implementation. Critical success factors for organizations include strong leadership and commitment to sustainability goals, consumer awareness and demand for sustainable products, collaboration with other organizations and stakeholders, and government policies and incentives that support circular practices [3].

Enablers for successful implementation include supportive regulations and policies that encourage circular practices, technological advancements that enable recycling and resource recovery, access to financing and investment, and education and training for employees and stakeholders.

Government Support and Policies

One of the most significant enablers for adopting circular economy practices is support from government policies and financial incentives. Government regulations can create a conducive environment by incentivizing companies through subsidies, tax breaks and grants [69, 143, 167]. Tax breaks and grants can alleviate the high initial transition costs that act as barriers. Clear standards help provide guidelines and evaluate progress on circular economy implementation [60, 83, 168-171]. Moreover, policies that mandate recycling and remanufacturing can enforce systematic changes throughout industries. Additionally, public procurement policies that prioritize circular products and services can create a market demand for CE solutions [5]. The success of such initiatives is often directly linked to the robustness of government support [14].

Access to Technology and Innovation

The capacity to access advanced technology for recycling and sustainable production processes stands out as a pivotal factor. Innovation in design and business models further enables the development of products that are easier to disassemble, repair and recycle, leading to more significant circularity [33, 96]. Redesigning products for longevity, repair, disassembly and recycling is a key enabler, as is optimizing processes to maximize resource productivity and minimize waste. Adopting digital technologies like the Internet of Things (IoT), blockchain and intelligent asset management systems can enhance the transparency, traceability and efficiency of material flows [50, 105]. Investment in research and development is crucial for developing innovative circular technologies and processes that enable closed-loop systems and waste minimization [10, 28, 39, 69, 171, 172]. Moreover, innovative product design and business models, such as product-as-a-service or leasing, can support the transition to a circular

economy by focusing on product longevity, reuse and recovery [60, 72, 73, 76, 81, 123, 146, 173, 174].

Education and Awareness

Education and awareness raising are critical enablers for successfully implementing CE practices within organizations. Employee training and skill development programmes focused on CE principles and practices can build the necessary competencies and foster a culture of sustainability [28, 67, 70, 115, 159, 175, 176]. Simultaneously, consumer awareness and demand for sustainable products are also key drivers for organizations to adopt CE practices. Educating consumers about the benefits of circular products and services can create market pull and support the transition to a circular economy [62, 98, 122, 132, 152, 157]. Educational programs and knowledge dissemination through various channels can help overcome informational barriers and increase the understanding of CE concepts among stakeholders. Education serves as both an internal and external enabler, harmonizing organizational practices with market expectations.

Collaboration and Partnerships

Collaborative efforts among businesses, industries and stakeholders facilitate the sharing of knowledge and resources, which is critical for achieving circularity [27, 39]. Engaging stakeholders, including suppliers, distributors, customers, governments, communities and NGOs, facilitates knowledge exchange, infrastructure development and identification of circular opportunities [17, 36, 65, 78, 175, 177]. Involving policymakers helps establish supportive regulations and incentives [29, 34]. Moreover, partnerships among companies, suppliers and customers can facilitate the development of a shared value chain vision [14].

Leadership and Organizational Commitment

Strong leadership and top management support are vital for successfully implementing CE practices within organizations [130]. Leaders must demonstrate a clear commitment to sustainability goals and integrate CE principles into the organization's core business strategy and operations [4, 66, 90, 111, 122, 124, 132, 144, 160, 174, 178]. Circular principles need to be strategically embedded within core business goals and operations, rather than within secondary initiatives [42, 158]. Organizations also require a shift toward a sustainability-oriented culture that embraces circular objectives [62, 66, 160].

Clear Planning and Strategic Vision

Having a clear strategic plan that integrates circular economy goals is fundamental [9, 41, 42, 126, 151]. Utilizing tools like lifecycle assessments can help organizations understand and manage the environmental impacts of their products throughout their lifecycle [36]. Strategic planning also involves adopting frameworks like the Sustainable Product Development Framework-Circular Business Model (SPDF-CBM) to guide organizations through their transition [36]. Despite potential resistance or uncertainty, a strong vision is key to driving organizational change toward circular models.

Measuring and Monitoring Progress

Measuring and monitoring progress is essential for organizations to assess the effectiveness of their CE practices and identify areas for improvement. The development of clear circularity indicators and metrics allows organizations to track their performance and benchmark against industry standards [56, 115, 116, 118]. Adoption of assessment tools, such as lifecycle assessment (LCA), can help organizations evaluate the environmental impact of their products and processes throughout the entire lifecycle [36, 73, 147, 179]. Continuous improvement and benchmarking against best practices enable organizations to refine their CE strategies and stay competitive in the market [61].

Table 4 summarizes the above discussion.

Table 4.
Critical success factors

Critical Success Factor	Description	Key Points
Government Support and Policies	Support from government policies and financial incentives is significant for CE adoption.	- Financial incentives (subsidies, tax breaks, grants) to offset transition costs - Clear regulations and standards to guide and evaluate CE implementation - Public procurement policies prioritizing circular products and services
Access to Technology and Innovation	The capacity to access advanced technology for recycling, sustainable production, and innovation in business models is pivotal.	- Digital technologies for transparency and efficiency - Innovative design and business models for easier disassembly, repair and recycling - Advanced technology for recycling and sustainable production processes
Education and Awareness	Education and raising awareness among employees and stakeholders about CE principles and practices.	- Employee training on CE principles and practices to build competencies - Consumer awareness campaigns to create market demand for circular products
Collaboration and Partnerships	Collaborative efforts among businesses, industries, and stakeholders facilitate sharing knowledge and resources.	- Sharing knowledge and resources among businesses, industries, and stakeholders - Engaging policymakers, suppliers, distributors and communities
Leadership and Organizational Commitment	Strong leadership and top management support are vital for integrating CE into core business strategies.	- Embedding CE principles into business operations - Strategic embedding within core business goals - Shift toward a sustainability-oriented culture
Clear Planning and Strategic Vision	Having a clear strategic plan that integrates CE goals	- Strategic planning involves adopting CE frameworks and tools - Utilizing tools like lifecycle assessments for understanding environmental impacts
Measuring and Monitoring Progress	Development of clear circularity indicators and metrics to track performance and benchmark against industry standards.	- Clear circularity indicators and metrics to track performance - Continuous improvement and benchmarking practices

Implementing circular economy practices effectively requires a holistic approach encompassing various critical success factors and enablers. Strong leadership and organizational commitment, supportive government policies and regulations, collaboration and stakeholder engagement, technology and innovation, education and awareness, and measuring and monitoring progress are all essential elements for successfully transitioning to a circular economy. Organizations must leverage these enablers to overcome barriers and drive the systemic change necessary for a sustainable future. Future research should focus on developing practical tools and frameworks to support organizations in their CE implementation efforts and exploring the role of emerging technologies and business models in accelerating the transition to a circular economy.

VIII.
Influence of Organizational Size on Circular Economy Adoption and Effectiveness

Analyzing the influence of organizational size on the adoption and effectiveness of CE practices reveals nuanced dynamics that underscore the complexity of implementing sustainable practices within varied organizational contexts. While larger organizations often possess the resources and capabilities to invest in CE initiatives, they may also face unique challenges in transitioning their established processes and complex supply chains [34, 111]. Conversely, smaller organizations might exhibit greater agility and adaptability but may lack the necessary capital and expertise to fully implement circular strategies [124, 131].

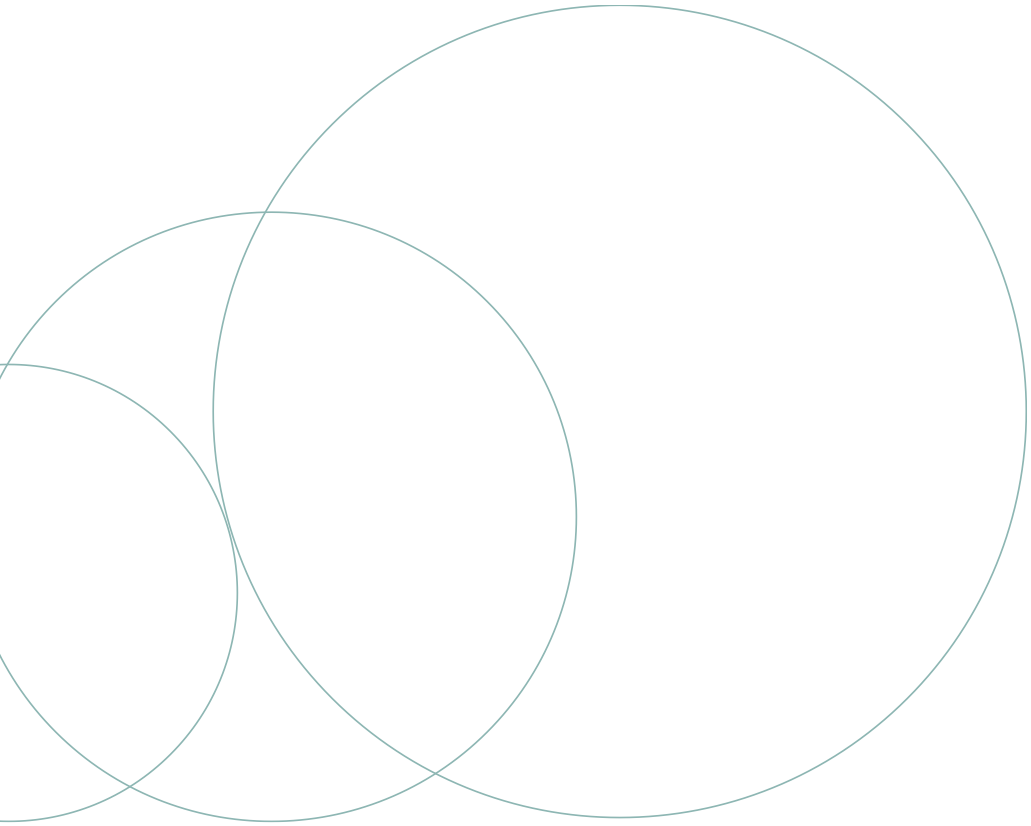
Table 5 provides a comparison of the advantages and challenges faced by larger organizations and SMEs regarding CE adoption and effectiveness.

Table 5.
Influence of organizational size on circular economy adoption and effectiveness

Aspect	Larger Organizations	SMEs
Advantages	- **Resource Availability**: Greater financial resources for CE technologies, infrastructure, and R&D, enabling comprehensive and impactful CE strategies [25, 112, 120, 145, 154, 165, 167]. - **Supply Chain Influence**: Significant power within supply chains to promote circularity throughout the value chain [33, 52, 139]. - **Market Access and Scale**: Better access to markets for recycled materials and circular products due to established networks and economies of scale [6, 8, 28, 69].	- **Agility and Flexibility**: Nimbleness and adaptability in implementing CE practices [7, 34, 95, 180]. - **Innovation Potential**: Creativity fostered by resource constraints [26, 129, 132]. - **Local Focus**: Strong ties to local communities, promoting localized circular economy initiatives [64, 98, 153].
Challenges	- **Organizational Complexity**: Difficulties in coordinating transitions within complex and geographically dispersed operations [26, 79, 111, 163]. - **Internal Barriers**: Resistance to change and competing priorities within the organization [62, 119, 170]. - Requires **extensive training** and engagement to overcome inertia [71, 86, 149] - **Stakeholder Expectations**: Greater scrutiny from investors, customers and regulators regarding sustainability performance [37, 50, 82]	- **Resource Constraints**: Limited financial resources, technology access, and challenges in achieving economies of scale [14, 52, 136, 150]. - **Knowledge Gaps**: Lack of awareness of CE principles [97, 154, 171]. - **Market Access**: Challenges in accessing markets due to limited networks [7, 105, 171]

Both organizational size and geographical location play crucial roles in shaping the adoption and effectiveness of circular economy practices. While larger organizations possess advantages in terms of resources and market access, they must overcome challenges related to organizational complexity and internal barriers. SMEs, on the other hand, can leverage their agility and innovation potential but need to address resource constraints and knowledge gaps. By understanding the unique opportunities and challenges faced by organizations of different sizes, stakeholders can develop targeted strategies and support mechanisms to promote the

widespread adoption and successful implementation of CE principles across diverse organizational contexts.



IX.
Future Research for Advancing CE in Organizations

The transition toward CE within organizations requires continuous research and development to address emerging challenges and opportunities. An analysis of the existing literature reveals several key areas in which future research can significantly contribute to advancing CE implementation in organizations.

Measurement and Evaluation:

A recurring theme across the literature is the need for improved measurement and evaluation tools for CE practices [54]. These tools should effectively quantify the economic, environmental and social impacts of CE practices. Researchers emphasize the importance of developing ***standardized metrics and indicators*** that can be applied across different industries and regions to facilitate benchmarking, progress tracking and data-driven decisions regarding their CE strategies [38, 96, 139]. This includes creating simpler and more accessible tools for organizations of varying sizes and resources [59, 69, 167]. Additionally, research should focus on ***quantifying the economic, environmental and social impacts*** of CE practices, enabling organizations to make data-driven decisions and to demonstrate the value proposition of CE [8, 31, 98]. This includes developing ***comprehensive lifecycle assessments*** that consider the full spectrum of impacts, including social equity and environmental regeneration [26].

Technology and Innovation:

The role of ***digital technologies*** in enabling and enhancing CE practices is a prominent area for future research [123]. Studies should explore the integration of technologies such as the ***Internet of Things, artificial intelligence, blockchain and big data analytics*** to optimize resource flows, improve traceability, and facilitate decision-making [88, 105, 107, 152, 158]. This includes investigating the potential of these technologies to support circular business models, such as product-as-a-service and sharing economy concepts [80, 89, 123, 141]. Furthermore, research should examine the ***impact of Industry 4.0*** on CE implementation, particularly in high-volume manufacturing sectors [77, 82, 121].

Organizational Factors and Change Management:

Understanding the ***organizational factors*** that influence CE adoption is crucial for successful implementation. Research should explore the role of ***organizational culture, leadership, employee engagement and stakeholder collaboration*** in driving or hindering CE initiatives [6, 14, 34]. This includes investigating the psychological and organizational factors that influence change readiness and the adoption of CE practices [98, 167]. Additionally, studies should examine the ***impact of organizational size and geographical location*** on CE implementation, considering the unique challenges and opportunities faced by SMEs and organizations in different regions [34, 37, 42, 66, 149].

Policy and Regulation:

The influence of ***policy and regulatory frameworks*** on CE adoption is a critical area for future research. Studies should examine the effectiveness of different policy instruments, such as ***extended producer responsibility (EPR), subsidies, taxes and regulations***, in promoting circular practices [41, 60, 61, 141] . This includes exploring the role of government in creating a supportive environment for CE through legislation, incentives and infrastructure development [26, 61, 101, 149, 152]. Furthermore, research should investigate the ***harmonization of CE policies*** across different regions and countries to facilitate a more consistent and effective transition [103].

Sector-Specific Challenges and Opportunities:

The need for sector-specific CE strategies and tools is paramount, as different industries encounter unique challenges and opportunities in adopting CE practices. Recognizing that CE implementation varies across different industries, future research should investigate ***sector-specific challenges and opportunities***. This includes identifying best practices and developing tailored strategies for CE adoption in various sectors, such as manufacturing, service, public and non-profit [131, 156, 180]. Studies should also explore the potential for

cross-sector collaboration and the creation of ***circular economy ecosystems*** to foster innovation and scale up solutions [70, 89, 91, 98].

Social and Economic Impacts:

While environmental benefits are often emphasized, future research should delve deeper into the ***social and economic impacts*** of CE. This includes investigating the effects of CE on job creation, workforce development, social equity and community engagement [153]. Additionally, research should explore the ***long-term economic viability*** of circular business models and the potential for CE to contribute to sustainable economic growth [76, 139, 173].

Consumer Behaviour and Market Dynamics:

Understanding ***consumer behaviour*** and its impact on CE adoption is crucial for developing effective strategies. Research can explore consumer preferences, attitudes and motivations related to circular products and services [8, 29, 98, 167]. This includes investigating the ***psychological barriers*** to consumer acceptance of circular models and developing targeted strategies to encourage sustainable consumption patterns [62, 117, 154, 167]. Moreover, investigating the impact of market dynamics and consumer demand on the adoption of CE models is essential for developing strategies that align with market realities [47, 54, 155].

Training and Capacity Building:

Enhancing the capacity of organizations to engage in CE practices through training and professional development is crucial, especially in developing countries [175]. Future research should explore the effectiveness of various educational programs and professional development initiatives in equipping stakeholders with the necessary CE competencies [6, 87, 101].

Emerging Trends and Future Directions:

Several emerging trends present exciting avenues for future research. These include the integration of ***circular economy principles with other sustainability concepts***, such as the sharing economy and biomimicry [88, 153, 170]. Additionally, research should explore the potential of ***new materials and technologies*** that facilitate circularity, such as bioplastics and advanced recycling processes [35, 80]. Furthermore, the role of ***social innovation and entrepreneurship*** in driving CE transitions needs to be investigated [88, 146].

Longitudinal studies are essential to assess the long-term economic, environmental and social impacts of CE practices on organizations. These studies can provide a more comprehensive understanding of the benefits and trade-offs associated with CE implementation [54, 102, 133, 136]. Additionally, there is a need for ***empirical research with primary data collection*** to validate the benefits of CE practices and to address gaps in the literature [53, 78, 87, 180].

These potential future directions can be summarized as in Table 6.

Table 6.
Future research directions

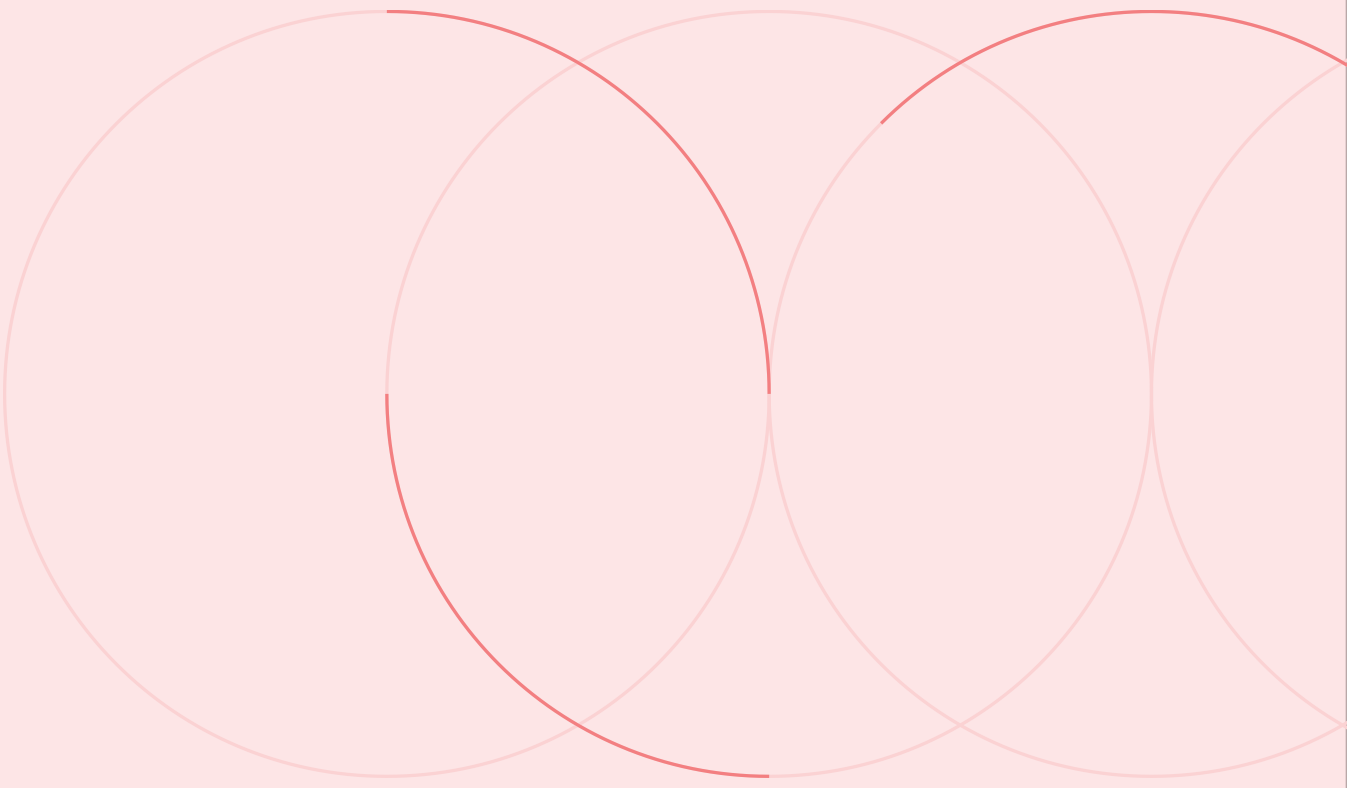
Research Area	Key Research Directions
Measurement and Evaluation	- Develop standardized metrics and indicators to quantify CE impacts (economic, environmental, social) - Create accessible tools for organizations of all sizes - Conduct comprehensive lifecycle assessments considering the full spectrum of impacts
Technology and Innovation	- Explore integration of digital technologies to optimize resource flows, traceability, and decision-making - Investigate the potential of these technologies for circular business models (PaaS, sharing economy) - Innovate in design and business models
Organizational Factors and Change Management	- Understand organizational factors influencing CE adoption (culture, leadership, employee engagement, stakeholder collaboration) - Investigate factors affecting change readiness and adoption of CE practices
Policy and Regulation	- Analyze effectiveness of policy instruments (EPR, subsidies, taxes, regulations) in promoting circular practices - Explore government's role in creating a supportive environment (legislation, incentives, infrastructure)

	- Investigate harmonization of CE policies across regions and countries
Sector-Specific Challenges and Opportunities	- Identify best practices and develop tailored CE adoption strategies for various sectors - Explore potential for cross-sector collaboration and circular economy ecosystems
Social and Economic Impacts	- Investigate effects of CE on job creation, workforce development, social equity, and community engagement - Assess the long-term economic viability of circular models
Consumer Behavior and Market Dynamics	- Explore consumer preferences, attitudes, and motivations related to circular products and services - Investigate psychological barriers to acceptance of circular models
Training and Capacity Building	- Evaluate the effectiveness of educational programs - Develop professional development initiatives
Emerging Trends	- Integrate CE principles with other sustainability concepts - Investigate the potential of new materials and technologies - Investigate the role of social innovation and entrepreneurship in driving CE transitions - Conduct longitudinal studies to assess the long-term impacts of CE practices - Conduct empirical research with primary data collection to validate benefits and address gaps in the literature

By addressing these future research needs and directions, scholars and practitioners can contribute to a deeper understanding of CE's role in promoting sustainable development within organizational frameworks and propose actionable strategies for policy formulation and practice enhancement in this evolving field.

X.
CONCLUSIONS

This systematic literature review offers a comprehensive overview of the integration of circular economy principles and practices across diverse organizational contexts. It showcases the multifaceted approaches organizations employ to adopt CE practices, highlighting the critical role of technological, policy, financial, cultural and social factors in facilitating or hindering this adoption. Through an in-depth examination of sector-specific strategies and models, the research underscores the unique pathways organizations traverse in integrating CE principles, thereby contributing to sustainable development's economic, environmental and social dimensions.



The findings illuminate a diverse array of drivers motivating organizations to adopt CE, ranging from environmental stewardship and economic incentives to compliance with evolving regulations and enhancing brand reputation. Nonetheless, organizations encounter significant barriers, including economic constraints, knowledge gaps, technological challenges and resistance to organizational change. These barriers underline the necessity of a nuanced understanding of the conditions under which CE principles can be effectively integrated into organizational practices.

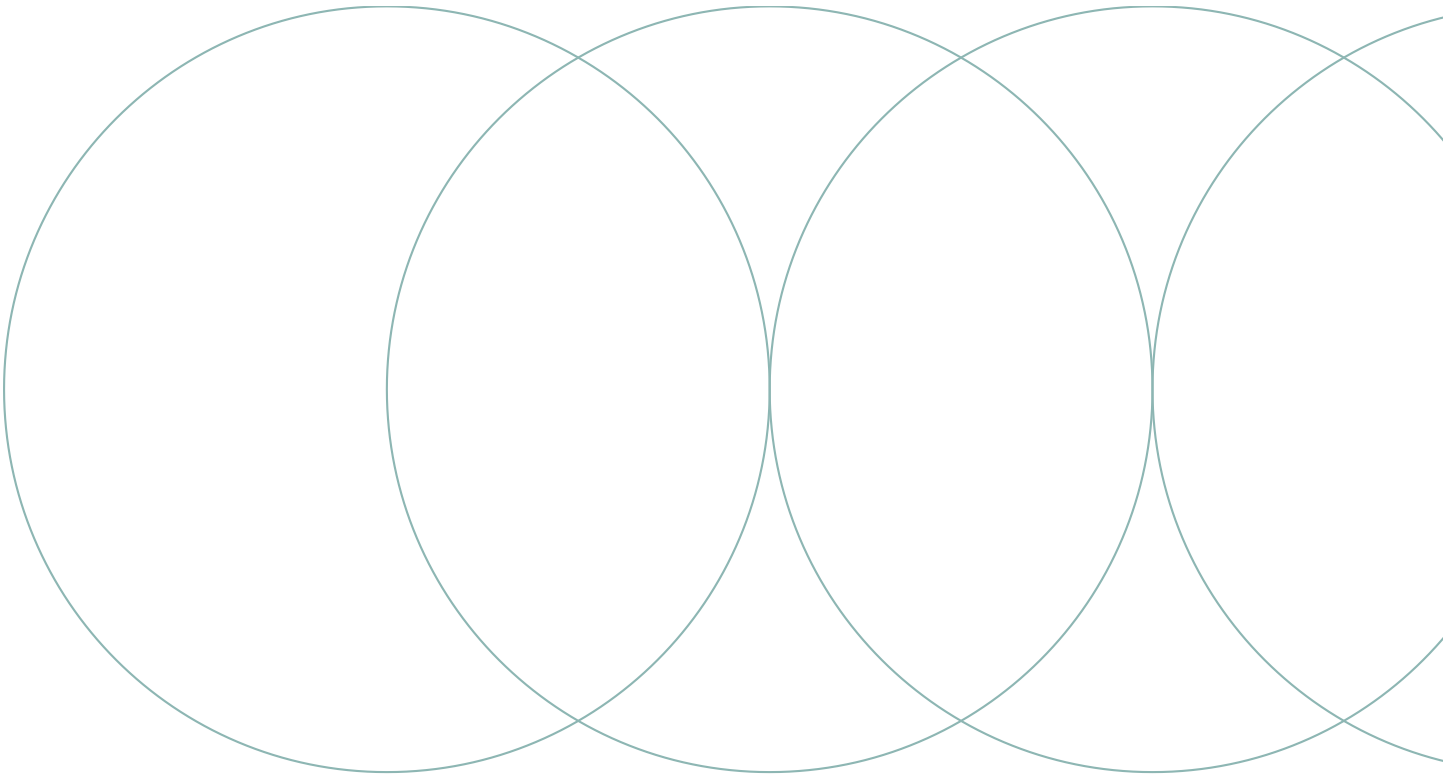
The study further revealed the influence of organizational size on the adoption and effectiveness of CE practices, indicating that both large corporations and small- and medium-sized enterprises play pivotal roles in advancing CE. However, their approaches and challenges differ, underscoring the need for tailored strategies that consider the specific contexts and capabilities of organizations of varying sizes.

Significantly, the research identifies critical success factors for CE implementation, emphasizing the importance of strong leadership, collaborative networks, government support, technological innovation and stakeholder engagement. These factors are essential enablers that can mitigate the barriers to CE adoption, facilitating the transition toward more sustainable organizational practices.

In conclusion, this study offers valuable insights into the complex dynamics of CE adoption within organizations, shedding light on the challenges, opportunities and success factors that shape this transition. By providing a comprehensive overview of CE practices across different organizational contexts, the research contributes to a deeper understanding of CE's role in promoting sustainable development. Furthermore, the study underscores the necessity for ongoing research, policy development and practice enhancement to address the evolving challenges and leverage the opportunities presented by the circular economy.

Future research should focus on developing practical tools and frameworks to support organizations in their CE journey, exploring the role of emerging technologies and business models and examining the social and economic impacts of CE practices. Policymakers and practitioners must collaborate to create conducive environments that support CE adoption, emphasizing education, innovation and stakeholder engagement as key drivers of

change. Together, these efforts can propel organizations toward a more sustainable, resilient and circular future, advancing the overarching goals of sustainable development.



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168. Kumar, V., Sezersan, I., Garza-Reyes, J.A., Gonzalez, E.D., Al-Shboul, M.d.A.: Circular economy in the manufacturing sector: benefits, opportunities and barriers. Management Decision 57, 1067-1086 (2019)

169. Purchase, C.K., Al Zulayq, D.M., O'Brien, B.T., Kowalewski, M.J., Berenjian, A., Tarighaleslami, A.H., Seifan, M.: Circular economy of construction and demolition waste: A literature review on lessons, challenges, and benefits. Materials 15, 76 (2021)

170. Betancourt Morales, C.M., Zartha Sossa, J.W.: Circular economy in Latin America: A systematic literature review. Business Strategy and the Environment 29, 2479-2497 (2020)

171. AlJaber, A., Martinez-Vazquez, P., Baniotopoulos, C.: Barriers and Enablers to the Adoption of Circular Economy Concept in the Building Sector: A Systematic Literature Review. Buildings 13, 2778 (2023)

172. Gu, Y., Wu, P., Du, R.: Corporate strategic positioning and environmental information disclosure under circular economy: evidence from China. Management Decision (2023)

173. Jabbour, C.J.C., Sarkis, J., de Sousa Jabbour, A.B.L., Renwick, D.W.S., Singh, S.K., Grebinevych, O., Kruglianskas, I., Godinho Filho, M.: Who is in charge? A review and a research agenda on the 'human side'of the circular economy. Journal of Cleaner Production 222, 793-801 (2019)

174. Bressanelli, G., Saccani, N., Pigosso, D.C., Perona, M.: Circular Economy in the WEEE industry: a systematic literature review and a research agenda. Sustainable Production and Consumption 23, 174-188 (2020)

175. de Jesus Pacheco, D.A., Rampasso, I.S., Michels, G.S., Ali, S.M., Hunt, J.D.: From linear to circular economy: The role of BS 8001: 2017 for green transition in small business in developing economies. Journal of Cleaner Production 140787 (2024)

176. van Dam, K., Simeone, L., Keskin, D., Baldassarre, B., Niero, M., Morelli, N.: Circular economy in industrial design research: a review. Sustainability 12, 10279 (2020)

177. Charef, R., Morel, J.-C., Rakhshan, K.: Barriers to implementing the circular economy in the construction industry: A critical review. Sustainability 13, 12989 (2021)

178. Leipold, S., Petit-Boix, A., Luo, A., Helander, H., Simoens, M., Ashton, W.S., Babbitt, C.W., Bala, A., Bening, C.R., Birkved, M.: Lessons, narratives, and research directions for a sustainable circular economy. Journal of Industrial Ecology 27, 6-18 (2023)

179. Ghisellini, P., Ripa, M., Ulgiati, S.: Exploring environmental and economic costs and benefits of a circular economy approach to the construction and demolition sector. A literature review. Journal of Cleaner Production 178, 618-643 (2018)

180. Liakos, N., Kumar, V., Pongsakornrungsilp, S., Garza-Reyes, J.A., Gupta, B., Pongsakornrungsilp, P.: Understanding circular economy awareness and practices in manufacturing firms. Journal of Enterprise Information Management 32, 563-584 (2019)

APPENDIX

Group 1 (100 studies): Literature review papers

Study	Details
R1	Agrawal, R., Wankhede, V. A., Kumar, A., Luthra, S., & Huisingh, D. (2022). Progress and trends in integrating Industry 4.0 within Circular Economy: A comprehensive literature review and future research propositions. *Business Strategy and the Environment*, *31*(1), 559–579.
R2	Alhawari, O., Awan, U., Bhutta, M. K. S., & Ülkü, M. A. (2021). Insights from circular economy literature: A review of extant definitions and unravelling paths to future research. *Sustainability*, *13*(2), 859.
R3	AlJaber, A., Martinez-Vazquez, P., & Baniotopoulos, C. (2023). Barriers and Enablers to the Adoption of Circular Economy Concept in the Building Sector: A Systematic Literature Review. *Buildings*, *13*(11), 2778.
R4	Awan, U., Sroufe, R., & Shahbaz, M. (2021). Industry 4.0 and the circular economy: A literature review and recommendations for future research. *Business Strategy and the Environment*, *30*(4), 2038–2060.
R5	Bassi, F., & Dias, J. G. (2019). The use of circular economy practices in SMEs across the EU. *Resources, Conservation and Recycling*, *146*, 523–533.
R6	Benachio, G. L. F., Freitas, M. D. C. D., & Tavares, S. F. (2020). Circular economy in the construction industry: A systematic literature review. *Journal of cleaner production*, *260*, 121046.
R7	Betancourt Morales, C. M., & Zartha Sossa, J. W. (2020). Circular economy in Latin America: A systematic literature review. *Business Strategy and the Environment*, *29*(6), 2479–2497.
R8	Bjørnbet, M. M., Skaar, C., Fet, A. M., & Schulte, K. Ø. (2021). Circular economy in manufacturing companies: A review of case study literature. *Journal of Cleaner Production*, *294*, 126268.
R9	Bressanelli, G., Saccani, N., Pigosso, D. C., & Perona, M. (2020). Circular Economy in the WEEE industry: a systematic literature review and a research agenda. *Sustainable Production and Consumption*, *23*, 174–188.

R10	Cagno, E., Neri, A., Negri, M., Bassani, C. A., & Lampertico, T. (2021). The role of digital technologies in operationalizing the circular economy transition: A systematic literature review. *Applied Sciences*, *11*(8), 3328.
R11	Camacho-Otero, J., Boks, C., & Pettersen, I. N. (2018). Consumption in the circular economy: A literature review. *Sustainability*, *10*(8), 2758.
R12	Carbonell-Alcocer, A., Romero-Luis, J., & Gertrudix, M. (2021). A methodological assessment based on a systematic review of circular economy and bioenergy addressed by education and communication. *Sustainability*, *13*(8), 4273.
R13	Centobelli, P., Cerchione, R., Chiaroni, D., Del Vecchio, P., & Urbinati, A. (2020). Designing business models in circular economy: A systematic literature review and research agenda. *Business Strategy and the Environment*, *29*(4), 1734–1749.
R14	Chakraborty, A., Barton, A., O'Loughlin, A., & Kandra, H. S. (2023). Exploratory Survey of Australian SMEs: an Investigation into the Barriers and Opportunities Associated with Circular Economy. *Circular Economy and Sustainability*, *3*(3), 1275–1297.
R15	Charef, R., Morel, J. C., & Rakhshan, K. (2021). Barriers to implementing the circular economy in the construction industry: A critical review. *Sustainability*, *13*(23), 12989.
R16	Chauhan, C., Parida, V., & Dhir, A. (2022). Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises. *Technological Forecasting and Social Change*, *177*, 121508.
R17	Chhimwal, M., Agrawal, S., & Kumar, G. (2022). Challenges in the implementation of circular economy in manufacturing industry. *Journal of Modelling in Management*, *17*(4), 1049–1077.
R18	Chouinard, U., Pigosso, D. C., McAloone, T. C., Baron, L., & Achiche, S. (2019). Potential of circular economy implementation in the mechatronics industry: An exploratory research. *Journal of Cleaner Production*, *239*, 118014.
R19	Çimen, Ö. (2021). Construction and built environment in circular economy: A comprehensive literature review. *Journal of cleaner production*, *305*, 127180.
R20	Cisternas, L. A., Ordóñez, J. I., Jeldres, R. I., & Serna-Guerrero, R. (2022). Toward the implementation of circular economy strategies: An overview of the current situation in mineral processing. *Mineral Processing and Extractive Metallurgy Review*, *43*(6), 775–797.

R21	Cristoni, N., & Tonelli, M. (2018). Perceptions of firms participating in a circular economy. *European Journal of Sustainable Development*, *7*(4), 105–105.
R22	de Melo, T. A., de Oliveira, M. A., de Sousa, S. R., Vieira, R. K., & Amaral, T. S. (2022). Circular economy public policies: A systematic literature review. *Procedia Computer Science*, *204*, 652–662.
R23	Dey, P. K., Malesios, C., De, D., Budhwar, P., Chowdhury, S., & Cheffi, W. (2022). Circular economy to enhance sustainability of small and medium sized enterprises. In *Supply chain sustainability in small and medium sized enterprises* (pp. 10–45). Routledge.
R24	dos Santos Gonçalves, P. V., & Campos, L. M. (2022). A systemic review for measuring circular economy with multi-criteria methods. *Environmental Science and Pollution Research*, 1–15.
R25	Esposito, B., Sessa, M. R., Sica, D., & Malandrino, O. (2020). Towards circular economy in the agri-food sector. A systematic literature review. *Sustainability*, *12*(18), 7401.
R26	Fan, Y., & Fang, C. (2020). Circular economy development in China-current situation, evaluation and policy implications. *Environmental impact assessment review*, *84*, 106441.
R27	Fonseca, L. M., Domingues, J. P., Pereira, M. T., Martins, F. F., & Zimon, D. (2018). Assessment of circular economy within Portuguese organizations. *Sustainability*, *10*(7), 2521.
R28	Fontana, A., Barni, A., Leone, D., Spirito, M., Tringale, A., Ferraris, M., ... & Goncalves, G. (2021). Circular economy strategies for equipment lifetime extension: A systematic review. *Sustainability*, *13*(3), 1117.
R29	Galvão, G. D. A., De Nadae, J., Clemente, D. H., Chinen, G., & De Carvalho, M. M. (2018). Circular economy: Overview of barriers. *Procedia Cirp*, *73*, 79–85.
R30	García-Quevedo, J., Jové-Llopis, E., & Martínez-Ros, E. (2020). Barriers to the circular economy in European small and medium-sized firms. *Business Strategy and the Environment*, *29*(6), 2450–2464.
R31	Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner production*, *114*, 11–32.

R32	Ghisellini, P., Ripa, M., & Ulgiati, S. (2018). Exploring environmental and economic costs and benefits of a circular economy approach to the construction and demolition sector. A literature review. *Journal of Cleaner Production*, *178*, 618–643.
R33	Gonçalves, B. D. S. M., Carvalho, F. L. D., & Fiorini, P. D. C. (2022). Circular economy and financial aspects: A systematic review of the literature. *Sustainability*, *14*(5), 3023.
R34	Govindan, K., & Hasanagic, M. (2018). A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective. *International Journal of Production Research*, *56*(1–2), 278–311.
R35	Goyal, S., Chauhan, S., & Mishra, P. (2021). Circular economy research: A bibliometric analysis (2000–2019) and future research insights. *Journal of cleaner production*, *287*, 125011.
R36	Grafström, J., & Aasma, S. (2021). Breaking circular economy barriers. *Journal of cleaner production*, *292*, 126002.
R37	Guerra, B. C., & Leite, F. (2021). Circular economy in the construction industry: An overview of United States stakeholders' awareness, major challenges, and enablers. *Resources, conservation and recycling*, *170*, 105617.
R38	Gusmerotti, N. M., Testa, F., Corsini, F., Pretner, G., & Iraldo, F. (2019). Drivers and approaches to the circular economy in manufacturing firms. *Journal of Cleaner Production*, *230*, 314–327.
R39	Halog, A., & Anieke, S. (2021). A review of circular economy studies in developed countries and its potential adoption in developing countries. *Circular Economy and Sustainability*, *1*, 209–230.
R40	Hamam, M., Chinnici, G., Di Vita, G., Pappalardo, G., Pecorino, B., Maesano, G., & D'Amico, M. (2021). Circular economy models in agro-food systems: A review. *Sustainability*, *13*(6), 3453.
R41	Heshmati, A. (2017). A review of the circular economy and its implementation. *International Journal of Green Economics*, *11*(3–4), 251–288.
R42	Homrich, A. S., Galvão, G., Abadia, L. G., & Carvalho, M. M. (2018). The circular economy umbrella: Trends and gaps on integrating pathways. *Journal of Cleaner Production*, *175*, 525–543.
R43	Jabbour, C. J. C., Sarkis, J., de Sousa Jabbour, A. B. L., Renwick, D. W. S., Singh, S. K., Grebinevych, O., ... & Godinho Filho, M. (2019). Who is in charge? A review and a

	research agenda on the ‘human side’of the circular economy. *Journal of cleaner production*, *222*, 793–801.
R44	Jäger-Roschko, M., & Petersen, M. (2022). Advancing the circular economy through information sharing: A systematic literature review. *Journal of Cleaner Production*, *369*, 133210.
R45	Jia, F., Yin, S., Chen, L., & Chen, X. (2020). The circular economy in the textile and apparel industry: A systematic literature review. *Journal of Cleaner Production*, *259*, 120728.
R46	Joensuu, T., Edelman, H., & Saari, A. (2020). Circular economy practices in the built environment. *Journal of cleaner production*, *276*, 124215.
R47	Kalmykova, Y., Sadagopan, M., & Rosado, L. (2018). Circular economy–From review of theories and practices to development of implementation tools. *Resources, conservation and recycling*, *135*, 190–201.
R48	Khitous, F., Strozzi, F., Urbinati, A., & Alberti, F. (2020). A systematic literature network analysis of existing themes and emerging research trends in circular economy. *Sustainability*, *12*(4), 1633.
R49	Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological economics*, *150*, 264–272.
R50	Klein, N., Deutz, P., & Ramos, T. B. (2022). A survey of Circular Economy initiatives in Portuguese central public sector organisations: National outlook for implementation. *Journal of environmental management*, *314*, 114982.
R51	Klein, N., Ramos, T. B., & Deutz, P. (2020). Circular economy practices and strategies in public sector organizations: An integrative review. *Sustainability*, *12*(10), 4181.
R52	Kumar, V., Sezersan, I., Garza-Reyes, J. A., Gonzalez, E. D., & Al-Shboul, M. D. A. (2019). Circular economy in the manufacturing sector: benefits, opportunities and barriers. *Management decision*, *57*(4), 1067–1086.
R53	Lahane, S., Prajapati, H., & Kant, R. (2021). Emergence of circular economy research: a systematic literature review. *Management of Environmental Quality: An International Journal*, *32*(3), 575–595.

R54	Lazaridou, D. C., Michailidis, A., & Trigkas, M. (2021). Exploring environmental and economic costs and benefits of a forest-based circular economy: A literature review. *Forests*, *12*(4), 436.
R55	Leipold, S., Petit-Boix, A., Luo, A., Helander, H., Simoens, M., Ashton, W. S., ... & Xue, B. (2023). Lessons, narratives, and research directions for a sustainable circular economy. *Journal of Industrial Ecology*, *27*(1), 6–18.
R56	Liakos, N., Kumar, V., Pongsakornrungsilp, S., Garza-Reyes, J. A., Gupta, B., & Pongsakornrungsilp, P. (2019). Understanding circular economy awareness and practices in manufacturing firms. *Journal of Enterprise Information Management*, *32*(4), 563–584.
R57	Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of cleaner production*, *115*, 36–51.
R58	Lobo, A., Trevisan, A. H., Liu, Q., Yang, M., & Mascarenhas, J. (2021, September). Barriers to transitioning towards smart circular economy: A systematic literature review. In *Proceedings of the International Conference on Sustainable Design and Manufacturing* (pp. 245–256). Singapore: Springer Singapore.
R59	MahmoumGonbadi, A., Genovese, A., & Sgalambro, A. (2021). Closed-loop supply chain design for the transition towards a circular economy: A systematic literature review of methods, applications and current gaps. *Journal of Cleaner Production*, *323*, 129101.
R60	Marrucci, L., Daddi, T., & Iraldo, F. (2019). The integration of circular economy with sustainable consumption and production tools: Systematic review and future research agenda. *Journal of Cleaner Production*, *240*, 118268.
R61	Martinho, V. J. P. D. (2021). Insights into circular economy indicators: Emphasizing dimensions of sustainability. *Environmental and Sustainability Indicators*, *10*, 100119.
R62	Masi, D., Day, S., & Godsell, J. (2017). Supply chain configurations in the circular economy: A systematic literature review. *Sustainability*, *9*(9), 1602.
R63	Masi, D., Kumar, V., Garza-Reyes, J. A., & Godsell, J. (2018). Towards a more circular economy: exploring the awareness, practices, and barriers from a focal firm perspective. *Production Planning & Control*, *29*(6), 539–550.

R64	Merli, R., Preziosi, M., & Acampora, A. (2018). How do scholars approach the circular economy? A systematic literature review. *Journal of cleaner production*, *178*, 703–722.
R65	Munaro, M. R., Tavares, S. F., & Bragança, L. (2020). Towards circular and more sustainable buildings: A systematic literature review on the circular economy in the built environment. *Journal of cleaner production*, *260*, 121134.
R66	Negri, M., Neri, A., Cagno, E., & Monfardini, G. (2021). Circular economy performance measurement in manufacturing firms: A systematic literature review with insights for small and medium enterprises and new adopters. *Sustainability*, *13*(16), 9049.
R67	Nikolaou, I. E., & Tsagarakis, K. P. (2021). An introduction to circular economy and sustainability: Some existing lessons and future directions. *Sustainable Production and Consumption*, *28*, 600–609.
R68	Ogunmakinde, O. E. (2019). A review of circular economy development models in China, Germany and Japan. *Recycling*, *4*(3), 27.
R69	Ogunmakinde, O. E., Sher, W., & Egbelakin, T. (2021). Circular economy pillars: A semi-systematic review. *Clean Technologies and Environmental Policy*, *23*, 899–914.
R70	Okorie, O., Salonitis, K., Charnley, F., Moreno, M., Turner, C., & Tiwari, A. (2018). Digitisation and the circular economy: A review of current research and future trends. *Energies*, *11*(11), 3009.
R71	Oluleye, B. I., Chan, D. W., Olawumi, T. O., & Saka, A. B. (2023). Assessment of symmetries and asymmetries on barriers to circular economy adoption in the construction industry towards zero waste: A survey of international experts. *Building and Environment*, *228*, 109885.
R72	Ouro-Salim, O., & Guarnieri, P. (2022). Circular economy of food waste: A literature review. *Environmental Quality Management*, *32*(2), 225–242.
R73	Padilla-Rivera, A., Russo-Garrido, S., & Merveille, N. (2020). Addressing the social aspects of a circular economy: A systematic literature review. *Sustainability*, *12*(19), 7912.
R74	Panchal, R., Singh, A., & Diwan, H. (2021). Does circular economy performance lead to sustainable development?–A systematic literature review. *Journal of Environmental Management*, *293*, 112811.

R75	Piscitelli, G., Ferazzoli, A., Petrillo, A., Cioffi, R., Parmentola, A., & Travaglioni, M. (2020). Circular economy models in the industry 4.0 era: a review of the last decade. *Procedia Manufacturing*, *42*, 227–234.
R76	Pishchulov, G. V., Richter, K. K., Pakhomova, N. V., & Tsenzharik, M. K. (2018). A circular economy perspective on sustainable supply chain management: an updated survey.
R77	Purchase, C. K., Al Zulayq, D. M., O'Brien, B. T., Kowalewski, M. J., Berenjian, A., Tarighaleslami, A. H., & Seifan, M. (2021). Circular economy of construction and demolition waste: A literature review on lessons, challenges, and benefits. *Materials*, *15*(1), 76.
R78	Rizvi, S. W. H., Agrawal, S., & Murtaza, Q. (2021). Circular economy under the impact of IT tools: A content-based review. *International Journal of Sustainable Engineering*, *14*(2), 87–97.
R79	Rodríguez, C., Florido, C., & Jacob, M. (2020). Circular economy contributions to the tourism sector: A critical literature review. *Sustainability*, *12*(11), 4338.
R80	Rosa, P., Sassanelli, C., Urbinati, A., Chiaroni, D., & Terzi, S. (2020). Assessing relations between Circular Economy and Industry 4.0: a systematic literature review. *International Journal of Production Research*, *58*(6), 1662–1687.
R81	Rusch, M., Schöggl, J. P., & Baumgartner, R. J. (2023). Application of digital technologies for sustainable product management in a circular economy: A review. *Business Strategy and the Environment*, *32*(3), 1159–1174.
R82	Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., & Kendall, A. (2019). A taxonomy of circular economy indicators. *Journal of Cleaner Production*, *207*, 542–559.
R83	Salvador, R., Barros, M. V., Freire, F., Halog, A., Piekarski, C. M., & Antonio, C. (2021). Circular economy strategies on business modelling: Identifying the greatest influences. *Journal of Cleaner Production*, *299*, 126918.
R84	Sarja, M., Onkila, T., & Mäkelä, M. (2021). A systematic literature review of the transition to the circular economy in business organizations: Obstacles, catalysts and ambivalences. *Journal of Cleaner Production*, *286*, 125492.
R85	Schöggl, J. P., Stumpf, L., & Baumgartner, R. J. (2020). The narrative of sustainability and circular economy–A longitudinal review of two decades of research. *Resources, Conservation and Recycling*, *163*, 105073.

R86	Sehnem, S., Vazquez-Brust, D., Pereira, S. C. F., & Campos, L. M. (2019). Circular economy: benefits, impacts and overlapping. *Supply Chain Management: An International Journal*, *24*(6), 784–804.
R87	Setyaningsih, S., Widjojo, R., & Kelle, P. (2024). Challenges and opportunities in sustainability reporting: a focus on small and medium enterprises (SMEs). *Cogent Business & Management*, *11*(1), 2298215.
R88	Singh, R., Khan, S., & Dsilva, J. (2023). A framework for assessment of critical factor for circular economy practice implementation. *Journal of Modelling in Management*, *18*(5), 1476–1497.
R89	Sumter, D., de Koning, J., Bakker, C., & Balkenende, R. (2021). Key competencies for design in a circular economy: Exploring gaps in design knowledge and skills for a circular economy. *Sustainability*, *13*(2), 776.
R90	Suzanne, E., Absi, N., & Borodin, V. (2020). Towards circular economy in production planning: Challenges and opportunities. *European Journal of Operational Research*, *287*(1), 168–190.
R91	Tan, J., Tan, F. J., & Ramakrishna, S. (2022). Transitioning to a circular economy: A systematic review of its drivers and barriers. *Sustainability*, *14*(3), 1757.
R92	Tiwari, D., Miscandlon, J., Tiwari, A., & Jewell, G. W. (2021). A review of circular economy research for electric motors and the role of industry 4.0 technologies. *Sustainability*, *13*(17), 9668.
R93	Tukker, A. (2015). Product services for a resource-efficient and circular economy–a review. *Journal of cleaner production*, *97*, 76–91.
R94	Türkeli, S., Kemp, R., Huang, B., Bleischwitz, R., & McDowall, W. (2018). Circular economy scientific knowledge in the European Union and China: A bibliometric, network and survey analysis (2006–2016). *Journal of cleaner production*, *197*, 1244–1261.
R95	van Dam, K., Simeone, L., Keskin, D., Baldassarre, B., Niero, M., & Morelli, N. (2020). Circular economy in industrial design research: a review. *Sustainability*, *12*(24), 10279.
R96	van Langen, S. K., Vassillo, C., Ghisellini, P., Restaino, D., Passaro, R., & Ulgiati, S. (2021). Promoting circular economy transition: A study about perceptions and awareness by different stakeholders groups. *Journal of Cleaner Production*, *316*, 128166.

R97	Vinante, C., Sacco, P., Orzes, G., & Borgianni, Y. (2021). Circular economy metrics: Literature review and company-level classification framework. *Journal of cleaner production*, *288*, 125090.
R98	Walker, A. M., Opferkuch, K., Roos Lindgreen, E., Raggi, A., Simboli, A., Vermeulen, W. J., ... & Salomone, R. (2022). What is the relation between circular economy and sustainability? Answers from frontrunner companies engaged with circular economy practices. *Circular Economy and Sustainability*, *2*(2), 731–758.
R99	Weigend Rodríguez, R., Pomponi, F., Webster, K., & D'Amico, B. (2020). The future of the circular economy and the circular economy of the future. *Built Environment Project and Asset Management*, *10*(4), 529–546.
R100	Ziegler, R., Poirier, C., Lacasse, M., & Murray, E. (2023). Circular economy and cooperatives—an exploratory survey. *Sustainability*, *15*(3), 2530.

Group 2 (70 studies): Studies published by North American Researchers

Study	Details
P1	Al-Awlaqi, M. A., & Aamer, A. M. (2022). Individual entrepreneurial factors affecting adoption of circular business models: an empirical study on small businesses in a highly resource-constrained economy. *Journal of Cleaner Production*, *379*, 134736.
P2	Ali, A. K., Layton, A., Kio, P., & Williams, J. (2021). Matrix Trays: From waste to opportunities. *Journal of Cleaner Production*, *300*, 126813.
P3	Allen, S. D., Zhu, Q., & Sarkis, J. (2021). Expanding conceptual boundaries of the sustainable supply chain management and circular economy nexus. *Cleaner Logistics and Supply Chain*, *2*, 100011.
P4	Alvarez-Risco, A., Rosen, M. A., & Del-Aguila-Arcentales, S. (2020). A new regulation for supporting a circular economy in the plastic industry: The case of Peru. *Journal of Landscape Ecology*, *13*(1), 1–3.
P5	Bai, C., Sarkis, J., Yin, F., & Dou, Y. (2020). Sustainable supply chain flexibility and its relationship to circular economy-target performance. *International Journal of Production Research*, *58*(19), 5893–5910.

P6	Barreiro-Gen, M., & Lozano, R. (2020). How circular is the circular economy? Analysing the implementation of circular economy in organisations. *Business Strategy and the Environment*, *29*(8), 3484–3494.
P7	Bauer, T., Zwolinski, P., Nasr, N., & Mandil, G. (2020). Characterization of circular strategies to better design circular industrial systems. *Journal of remanufacturing*, *10*, 161–176.
P8	Beaurain, C., Chembessi, C., & Rajaonson, J. (2023). Investigating the cultural dimension of circular economy: A pragmatist perspective. *Journal of Cleaner Production*, *417*, 138012.
P9	Brändström, J., Jazairy, A., & Roos Lindgreen, E. (2024). Barriers to adopting circular business models: A cross-sectoral analysis. *Business Strategy and the Environment*.
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