The Evolution of Circular Economy: A Literature Review on Sustainability Transitions and Challenges

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ABSTRACT

The aim of this study is to conduct a comprehensive literature review on Circular Economy and Sustainability. The review identifies significant gaps in the understanding of Circular Economy's implementation, as well as the multifaceted challenges associated with transitioning from linear to circular models. The study highlights key developments, transitions, and challenges within Circular Economy literature, including barriers and enablers across different sectors, providing insights into the factors that facilitate successful transitions. By pinpointing critical gaps in existing research, this review sheds light on the key drivers of Circular Economy transitions and suggests pathways for overcoming the challenges that impede the global adoption of Circular Economy practices. Future research in Circular Economy should prioritize addressing barriers to implementation, such as market dynamics, consumer behavior, and regulatory obstacles, while also exploring innovative technologies and their applications in various sectors. By promoting interdisciplinary and cross-industry collaboration, Circular Economy research can help build a more sustainable and resilient economic future.

Keywords: Circular Economy, Sustainability, Evolution, Transitions, Challenges

INTRODUCTION

The concept of Circular Economy (CE) has emerged as a pivotal framework for sustainable development, particularly in light of escalating global challenges such as resource depletion, environmental degradation, and climate change. CE represents a paradigm shift from the traditional linear economic model characterized by a "take, make, dispose" approach to a more regenerative system that emphasizes reducing, reusing, and recycling materials. This transition is critical for minimizing waste and maximizing resource efficiency, thereby contributing significantly to sustainability goals (Geissdoerfer et al., 2017; Murray et al., 2015). The evolution of CE principles has been shaped by various factors, including technological advancements, policy frameworks, and innovative business models, which collectively facilitate the transition from linear to circular systems (Dewick et al., 2020; Ocolișanu et al., 2022).

The motivation for conducting a literature review on CE is underscored by the increasing recognition of its potential to decouple economic growth from finite resource consumption. As global economies grapple with the pressing need for sustainable practices, CE offers a viable pathway to achieve this decoupling through closed-loop systems (Jakubelskas, 2023; Idrus, 2024). However, despite the growing body of literature on CE, significant gaps remain in understanding its comprehensive implementation and the multifaceted challenges associated with transitioning from linear to circular models. Many existing studies tend to focus on specific case applications or particular industries, which leaves a void in knowledge regarding broader systemic barriers and enablers that affect CE adoption across various sectors and geographical contexts (Meng, 2023; Garcés-Ayerbe et al., 2019).

Furthermore, the intersection of policy, innovation, and market dynamics in facilitating CE transitions is often underexplored, highlighting the need for further research in this area (Ozili, 2021; Apriantoro, 2024). This literature review aims to synthesize key developments, transitions, and challenges within CE literature, thereby providing a comprehensive overview of the sustainability transitions associated with CE practices. It seeks to trace the evolution of CE concepts, mapping how innovation, policy, and business models have evolved to support this shift (Pieroni et al., 2018; Mashovic et al., 2022).

Additionally, the review will explore the barriers and enablers of CE across different sectors, offering insights into the factors that influence successful transitions. By identifying critical gaps in current research, this review will highlight the key drivers of CE transitions and propose pathways for overcoming the challenges that hinder the global adoption of CE practices (Koval et al., 2023; Castro et al., 2022). The article structure systematically explores themes within the CE and its associated challenges. It begins with an introduction that frames the importance of CE in global sustainability, followed by a literature review that highlights developments, sector transitions, and challenges, while also exploring practical implications. The conclusions and future directions summarize key insights, address research gaps, and propose pathways to advance the global shift towards a circular economy.

LITERATURE REVIEW

The Evolution of Circular Economy Concepts

The evolution of CE concepts can be traced back to foundational thinkers who integrated diverse disciplines such as economics, ecology, and design to establish a framework that emphasizes resource efficiency and sustainability. Kenneth Boulding is often credited as a pioneer of CE thinking, particularly through his influential essay "The Economics of the Coming Spaceship Earth," where he introduced the notion of a "closed economy of permanence." This concept contrasts sharply with the "cowboy economy," which is characterized by unrestrained resource exploitation. Boulding's metaphor of Earth as a spaceship with finite resources laid the groundwork for understanding the necessity of recycling and resource reuse, which are central tenets of CE (Lewandowska et al., 2022, Viglioglia et al., 2021).

Walter Stahel further advanced CE concepts with his 1982 report "The Product Life Factor," advocating for a "closed-loop economy" where products are designed for reuse, repair, or remanufacturing rather than disposal. Stahel's emphasis on a performance economy, which prioritizes services over products, incentivizes manufacturers to create durable goods, thereby extending product lifecycles and minimizing waste. His contributions have been instrumental in shaping modern CE principles that focus on sustainability and industrial resilience.

The work of Michael Braungart and William McDonough in their 2002 book "Cradle to Cradle: Remaking the Way We Make Things" further elaborates on regenerative design, advocating for products that can re-enter biological or technical cycles post-use. This cradle-to-cradle philosophy emphasizes waste elimination and resource recovery, forming a cornerstone of contemporary CE practices (Mang & Reed, 2017). Similarly, Robert Frosch and Nicholas Gallopoulos's 1989 paper on industrial ecology introduced the idea of industries functioning as interconnected systems, where waste from one process can serve as input for another, mirroring natural ecosystems. This perspective is vital for developing closed-loop systems that are essential to CE (Ghisellini et al., 2016).

John Lyle's concept of regenerative design, articulated in his 1994 book "Regenerative Design for Sustainable Development," also plays a crucial role in CE evolution. Lyle proposed design strategies that restore and renew energy and material sources, emphasizing systems thinking and sustainability from the outset. His ideas have significantly influenced sustainable architecture and urban planning, reinforcing the importance of designing for long-term ecological health (Motloch, 1995).

Gunter Pauli's 2010 work "The Blue Economy" expanded on CE principles by promoting innovative business models that generate zero waste and operate harmoniously with natural systems. Pauli's approach encourages the transformation of waste into valuable resources, thereby enhancing environmental health and sustainability (Hira et al., 2022). Collectively, these early contributions have established a robust intellectual foundation for CE, which continues to evolve and gain traction across various industries and regions as a sustainable economic framework.

Emergence in Policy and Practice

The integration of CE principles into policy frameworks is crucial for advancing sustainability globally. The European Union (EU) has emerged as a leader in this transition, particularly through its Circular Economy Action Plan, first launched in 2015 and updated in 2020. This plan is a key component of the European Green Deal, aiming to transform the EU into a climate-neutral and resource-efficient economy by 2050. It emphasizes sustainable product design, circular business models, waste reduction, and innovation funding, thereby promoting a systemic shift towards sustainability (Vanhamäki et al., 2021; Gottardo et al., 2021).

Key elements of the EU's plan include the Sustainable Product Policy Framework, which aims to enhance product durability and recyclability, and the promotion of circular business models that encourage resource efficiency (Levicky et al., 2021). Additionally, the plan sets ambitious recycling targets and mandates extended producer responsibility, requiring manufacturers to manage their products throughout their lifecycle (Pesce et al., 2020). The EU's approach serves as a model for supranational governance, demonstrating how legal and regulatory frameworks can facilitate the adoption of CE principles (Gottardo et al., 2021).

The key elements of the plan include:

1. Sustainable Product Policy Framework: This aims to make products more durable, repairable, and recyclable, reducing the environmental footprint throughout their lifecycle. The plan proposes eco-design measures to minimize waste and promote the use of sustainable materials in product manufacturing.

2. CE in Production and Consumption: The EU plan encourages the adoption of circular business models, promotes the sharing economy, and incentivizes businesses to design products with resource efficiency in mind.

3. Waste Reduction and Recycling: It sets ambitious targets for recycling and waste reduction, including stricter rules on waste management and extended producer responsibility, which requires manufacturers to take responsibility for the entire lifecycle of their products, from production to post-consumer waste.

4. Economic Support and Innovation: The EU allocates funding to support CE innovations, with a focus on research and development, particularly in areas such as digitalization and industrial symbiosis. The Action Plan also encourages member states to create incentives for businesses adopting CE practices.

In parallel, China has made significant strides in integrating CE principles through its Circular Economy Promotion Law, enacted in 2009 and updated in 2018. This law addresses environmental degradation and resource scarcity while supporting economic growth. It emphasizes resource efficiency, pollution reduction, and mandates government leadership in promoting CE practices (Pesce et al., 2020). Key provisions include extended producer responsibility and urban waste management initiatives, which aim to enhance recycling rates and promote sustainable consumption (Beccarello & Foggia, 2022). China's efforts reflect a comprehensive strategy to align industrial development with environmental protection, showcasing the potential of CE policies to drive sustainable economic growth (Tu et al., 2021). The details of the key provisions of the law include:

1. Resource Efficiency and Pollution Reduction: The law emphasizes improving resource efficiency by promoting cleaner production processes, reducing resource consumption, and encouraging the reuse and recycling of waste materials in industrial processes. The focus is on industries that are energy- and resource-intensive, such as steel, cement, and electronics.

2. Government Leadership and Regulation: The law mandates government agencies at various levels to incorporate CE principles into development plans, including setting mandatory recycling targets and requiring businesses to adopt energy-efficient technologies. Local governments are responsible for enforcing CE-related policies and providing financial support and incentives for circular practices.

3. Extended Producer Responsibility (EPR): Similar to the EU, China's law imposes extended producer responsibility, requiring manufacturers to manage the entire lifecycle of their products, including post-consumer disposal and recycling.

4. Urban Waste Management and Recycling: China's CE policy also includes urban waste management initiatives, such as improving municipal recycling systems, promoting the recovery of construction and demolition materials, and enhancing recycling rates for household waste.

5. Public Awareness and Education: The law emphasizes the importance of public awareness and education campaigns to encourage sustainable consumption patterns and promote CE concepts at the community level.

China's Circular Economy Promotion Law has significantly influenced the development of eco-industrial parks (EIPs), fostering collaboration among businesses to recycle waste, reduce emissions, and share resources, thereby creating closed-loop systems. Enacted in 2008, this law marked a pivotal shift in China's approach to economic growth, emphasizing the need to align industrial development with environmental sustainability (Hu et al., 2018; Zhu et al., 2018).

The national demonstration EIP program initiated in 2000 has facilitated the eco-transformation of industrial parks, with various ministries collaborating to promote cleaner production processes and resource efficiency (Guo et al., 2017). These parks serve as models for sustainable industrial practices, where companies work together to minimize waste and enhance resource recovery, addressing critical issues of resource depletion and pollution (Mathews & Tan, 2011; He & Li, 2023).

Moreover, the law mandates extended producer responsibility, compelling manufacturers to manage their products' entire lifecycle, including post-consumer waste (Zhu et al., 2018). This regulatory framework not only drives innovation in waste management but also promotes public awareness and education on sustainable practices (Hu et al., 2018). Overall, China's initiatives reflect a comprehensive strategy to integrate CE principles into national policy, demonstrating the potential for EIPs to contribute to both economic growth and environmental protection.

The Adoption of CE in Various Industries

The adoption of Circular Economy (CE) principles across various industries, particularly in manufacturing and waste management, has significantly enhanced sustainability by minimizing waste, conserving resources, and fostering resilient economic systems. In the manufacturing sector, CE emphasizes resource efficiency, durability, and material recycling, allowing companies to reduce their reliance on virgin resources and lower greenhouse gas emissions. For example, implementing CE practices can lead to substantial reductions in energy consumption and waste, thereby contributing to the industry's sustainability objectives (Romero-Hernández & Romero, 2018). Through improved operational performance, waste is eliminated, ultimately strengthening both financial and environmental sustainability (Anuar et al., 2017).

In the waste management sector, the integration of CE principles is crucial for promoting recycling and material recovery. By diverting materials from landfills and enhancing resource recovery, CE practices help mitigate pollution and conserve natural resources. Sustainable waste management strategies not only reduce

environmental impacts but also create economic opportunities by transforming waste into valuable resources (Skvarciany et al., 2021). For example, companies that embrace CE can potentially eliminate millions of tons of solid waste while generating significant cost savings (Romero-Hernández & Romero, 2018).

Moreover, the construction industry is increasingly adopting CE principles to address challenges related to construction and demolition waste. The implementation of the 3Rs (reduce, reuse, recycle) is evolving into a more comprehensive CE approach that aims to create restorative and regenerative systems (Salleh et al., 2022). This shift underscores the potential of CE to drive innovation and efficiency across various sectors, ultimately contributing to a more sustainable future.

Evolution in Theoretical Frameworks

The evolution of CE models marks a significant transition from traditional linear systems to sustainable closed-loop systems. Initially, linear economic models operated on a "take-make-dispose" paradigm, heavily reliant on raw material extraction and resulting in substantial waste accumulation and resource depletion Negrete-Cardoso et al. (2022). As environmental concerns intensified, the CE model emerged, emphasizing waste reduction through practices such as reusing, recycling, and regenerating materials. This shift reflects a growing recognition of the need for integrated strategies that mitigate the negative impacts of linear economies (Amir et al., 2022).

Closed-loop systems, a fundamental aspect of CE, aim to maintain materials in circulation for as long as possible, thereby minimizing the demand for new resources and reducing environmental impacts. These systems promote a continuous flow of products, materials, and resources, ensuring that waste is minimized and resource efficiency is maximized (Geissdoerfer et al., 2017). The transition from linear to closed-loop systems signifies a paradigm shift towards sustainability, highlighting the importance of holistic value management over mere waste management (Amir et al., 2022). Strategic planning for a circular economy model necessitates collaboration within the business model, involving the development of strategic partnerships, investment planning, and effective management of human resources (Ting et al., 2023).

Moreover, the adoption of CE principles has been linked to various sectors, including agriculture and manufacturing, where the focus is on creating regenerative systems that restore environmental health while optimizing resource use (Bhattarai et al., 2021). This comprehensive approach not only addresses ecological concerns but also fosters economic resilience by creating new opportunities for innovation and job creation (Mashovic et al., 2022). As such, the evolution of CE models represents a critical response to the challenges posed by traditional economic practices, paving the way for a more sustainable future (Ahmed et al., 2022). Table 1 offers a comprehensive overview of key publications of the studies in CE and Sustainability.

Table 1. Key publications of the studies in CE and Sustainability.

Authors	**Title**	**Topics**	**Main Findings**
Wei et al. (2022)	The analysis of optimized path selection for management mode of coastal regional circular economy based on fuzzy decision algorithm	Sustainable Development, Circular Economy	Proposes a decision-making framework for evaluating environmental pillars of regional circular economies using multi-criteria methods.
Kio et al. (2022)	Circular Economy Trends – Potential Role of Emerging Technologies	Circular Economy, Digital Economy	Discusses the role of digital technologies in enabling circular economy strategies and the need for systematic guidance in their application.
Ciliberto et al. (2021)	Enabling the Circular Economy transition: a sustainable lean	Business, Lean Manufacturing	Links sustainable production with CE principles, emphasizing strategies for

	manufacturing recipe for Industry 4.0		increasing efficiency and reducing environmental impacts.
Suchek et al. (2021)	Innovation and the circular economy: A systematic literature review	Circular Economy, Innovation	Highlights the importance of combining policies for climate change mitigation with technological innovations to drive circular and sustainable practices.
Romero et al. (2021)	Synergy between Circular Economy and Industry 4.0: A Literature Review	Circular Economy, Industry 4.0	Discusses how Industry 4.0 technologies can enhance circular economy practices, using case studies to support theoretical frameworks.
Padilla-Rivera et al. (2020)	Addressing the Social Aspects of a Circular Economy: A Systematic Literature Review	Social Dimensions, Circular Economy	Analyzes how social aspects are integrated into CE research, highlighting the importance of social dimensions in policy-making for sustainable development.
Corsini et al. (2019)	The Advent of Practice Theories in Research on Sustainable Consumption: Past, Current and Future Directions of the Field	Practice Theory, Consumption, Sustainability	Explores the application of practice theory in circular and sharing economies, emphasizing the need for sustainable consumption behaviors.
Millar et al. (2019)	The Circular Economy: Swings and Roundabouts?	Circular Economy, Sustainable Development	Examines the contradictions and knowledge gaps in how CE can promote sustainable development and social equity.
Geissdoerfer et al. (2017)	The Circular Economy – A new sustainability paradigm?	Circular Economy, Sustainability	Investigates the relationship between CE and sustainability, emphasizing the need for understanding their impacts on supply chains and business models.

Sustainability Transitions within the Circular Economy

Sustainability transitions within the CE are driven by various factors, including innovation, policy and governance, and social and economic drivers. These components work synergistically to promote the shift from a traditional linear economy (take-make-dispose) to a circular one that emphasizes resource efficiency, waste minimization, and sustainable development.

i. Role of Innovation

Innovation is pivotal in advancing sustainability within the CE by fostering the development and implementation of technologies that enhance resource recovery and minimize waste. Recycling technologies and digital platforms for product sharing facilitate the adoption of circular business models, enabling practices such as product lifecycle extensions and remanufacturing, which are essential for resource conservation and waste reduction (Insanic & Gadde, 2014; Reddy, 2023). Furthermore, the integration of eco-friendly materials into product design not only supports sustainability but also encourages the redesign of processes to optimize resource utilization (Kehrein et al., 2020; Shirazi, 2023). Innovative approaches, such as anaerobic membrane bioreactors and microbial fuel cells, exemplify how technological advancements can transform wastewater treatment into a resource recovery process, thereby contributing to both environmental sustainability and

economic viability (Qin & He, 2017; Robles et al., 2021). The emphasis on metrics for sustainability allows organizations to track progress and align their practices with the three pillars of sustainability: environmental, economic, and social (Cornejo et al., 2019; Iacovidou et al., 2017). Thus, innovation is not merely a facilitator but a necessary driver for achieving a sustainable CE.

ii. Policy and Governance Drivers

Policy and governance are essential for fostering an enabling environment for the adoption of circular economy (CE) practices. Governments can facilitate this transition through regulations, incentives, and sustainability-focused policies such as Extended Producer Responsibility (EPR) and waste reduction targets. For instance, the European Union's Circular Economy Action Plan exemplifies how governance can drive CE initiatives across various industries, promoting a cohesive regulatory framework that aligns with both environmental and economic objectives (Levicky et al., 2021; Kirchherr et al., 2018). Effective policy frameworks not only establish clear guidelines but also encourage market demand for circular products, addressing barriers that hinder CE adoption (Gopan, 2023). The integration of CE principles into environmental regulations has been shown to enhance resource efficiency and sustainable production practices (Saeed, 2023). Furthermore, the establishment of monitoring frameworks allows for the assessment of progress towards circularity, ensuring that policies remain effective and adaptive to changing circumstances (Kirchherr et al., 2018). Thus, robust governance structures are vital for realizing the full potential of the CE.

iii. Social and Economic Drivers

Social awareness and economic factors play a pivotal role in the transition to CE principles. The implemented social sustainability performance indicators are a component of the broader sustainability framework, designed to provide a comprehensive and balanced view of sustainability performance at the operational level in manufacturing, alongside economic and environmental aspects (Shaharudin et al., 2022a). Increasing consumer demand for sustainable products drives businesses to adopt circular strategies, as consumers are becoming more conscious of the environmental impacts of their purchases (Siregar, 2023). This shift not only encourages companies to innovate but also leads to economic benefits such as cost savings, enhanced resource efficiency, and the creation of new jobs in the green economy (Bassi & Guidolin, 2021). For instance, the integration of CE practices in manufacturing can transform waste into valuable resources, promoting environmentally friendly economic growth (Siregar, 2023).

In addition, CE fosters social equity by optimizing resource use for future generations and minimizing waste, thereby creating long-term value for both society and the economy (Bușu & Bușu, 2018). The role of social economy enterprises is particularly significant, as they contribute to the CE and green transition by promoting inclusive practices and stakeholder engagement (Barna et al., 2023). This inclusivity enhances social acceptance of circular products and green technologies, further facilitating the transition to sustainable practices (Trică et al., 2019; Shaharudin et al., 2018).

Moreover, the CE has been recognized as a viable model for achieving sustainable development goals, as it balances economic growth with environmental protection (Mashovic et al., 2022). By leveraging circular investments and fostering innovation, CE can drive economic growth while addressing pressing environmental challenges (Feng & Lam, 2021). Thus, the interplay of social awareness and economic incentives is crucial for advancing the adoption of CE across various sectors.

CHALLENGES IN IMPLEMENTING CIRCULAR ECONOMY FOR SUSTAINABILITY

Implementing CE principles for sustainability faces numerous challenges across various domains, including technical, infrastructural, economic, social, and regulatory aspects. Addressing these barriers is essential for successfully transitioning from traditional linear economic models to sustainable circular systems.

Technical and infrastructural challenges are significant hurdles in many industries, where existing technologies are primarily optimized for linear processes characterized by a "take-make-dispose" approach. Transitioning to circular practices often necessitates substantial investments in new technologies and the development of

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infrastructure to support recycling, remanufacturing, and reverse logistics (Supanut, 2024). The lack of adequate infrastructure can lead to inefficiencies in material recovery and resource circulation, further complicating the implementation of CE (Supanut, 2024).

In addition, economic barriers also impede the widespread adoption of CE. The initial costs associated with implementing circular practices, including investments in technology and infrastructure, can be prohibitively high, particularly for small and medium-sized enterprises (SMEs) (Szilagyi et al., 2022). Additionally, fluctuating commodity prices can render recycling and resource recovery financially unviable compared to the use of virgin materials, creating a disincentive for businesses to adopt circular practices (Millar et al., 2019). The persistence of linear business models and a lack of market incentives further slow the transition to CE (Didenko et al., 2018).

Moreover, social and behavioral factors present additional challenges. Consumer attitudes, shaped by a culture of consumption, often prioritize immediate gratification over product longevity, reuse, or recycling (Rada et al., 2017). Changing these behaviors requires substantial education and awareness efforts, and even when awareness is raised, there is frequently a gap between intentions and actions (Ciliberto et al., 2021).

Finally, policy and regulatory frameworks can pose considerable challenges. Inconsistent regulations across regions complicate the standardization of circular practices for companies operating in multiple jurisdictions (Idrus, 2024). Existing regulations often favor linear economic models, lacking the necessary policies to encourage resource recovery, material reuse, and product life extension. Regulatory inertia and the absence of comprehensive legislation promoting CE can significantly hinder progress (Lakatos et al., 2021). Table 2 summarizing past studies on the challenges in implementing Circular Economy (CE) for sustainability

Table 2. Summary of the past studies on the challenges in implementing CE for sustainability

Authors	Year	Title	Method	Main Findings
Nandha Gopan & Balaji	2023	Indian automotive supply chains: Barriers to CE for sustainable development	Case Studies and Interviews	Highlighted key barriers such as infrastructure limitations, lack of policy support, and high costs in implementing CE practices in the Indian automotive industry.
Saeed, S., et al.	2023	Advancing circular economy in industrial chemistry and environmental engineering	Literature Review	Discussed challenges like the alignment of CE principles with SDGs and technical barriers in resource recovery, along with the need for standardized regulations.
Levicky, M., et al.	2021	Progress in the transition of the circular economy in Slovakia and the EU	Comparative Analysis	Identified slow policy implementation and low market demand as significant barriers to CE transition in Slovakia compared to other EU nations.
Kehrein, P., et al.	2020	A critical review of resource recovery from municipal wastewater treatment plants	Critical Review	Reviewed technical and infrastructural barriers in resource recovery, emphasizing market bottlenecks and technology-related limitations in circular practices.
Kirchherr, J., et al.	2018	Barriers to the circular economy: Evidence from the EU	Survey and Interviews	Identified major barriers including lack of consumer awareness, regulatory constraints, and financial challenges in adopting CE in the European Union.

KEY TRENDS AND FUTURE DIRECTIONS IN CE RESEARCH

The research landscape surrounding CE has expanded significantly, reflecting a growing recognition of the need to transition from traditional linear economic models to sustainable, closed-loop systems. This evolution can be categorized into three main areas: emerging themes, interdisciplinary approaches, and future research directions.

One prominent emerging theme in CE research is the increasing emphasis on resource recovery and waste-to-resource transformation. This shift underscores the importance of creating closed-loop systems that maximize resource efficiency while minimizing waste (Shaharudin et al., 2022b). Recent studies highlight the role of technological innovations, such as blockchain, artificial intelligence (AI), and big data, in tracking resource flows and optimizing circular practices (Pollard et al., 2022). For instance, the application of circularity indicators in the electrical and electronic sector demonstrates how organizations can adopt circular economy business models (CEBMs) to enhance sustainability (Pollard et al., 2022).

Another critical theme is the integration of circular practices across various industries, including manufacturing, construction, and electronics. This trend reflects a systemic change that seeks to embed circularity throughout entire value chains rather than relying on isolated initiatives (Chen et al., 2021). The qualitative content analysis of CE roles in industry emphasizes the need for comprehensive strategies that address environmental sustainability (Bawono, 2022).

Interdisciplinary research has become a cornerstone of CE studies, as the transition to a CE necessitates collaboration across diverse fields such as engineering, environmental science, economics, and social sciences. For example, environmental science provides insights into the ecological impacts of circular strategies, while economics explores the financial mechanisms that drive circular adoption (Lahti et al., 2018). Social sciences contribute to understanding consumer behavior and policy-making processes essential for facilitating circularity transitions (Mykkänen & Repo, 2021). This interdisciplinary nature is further reflected in studies that examine the intersection of technology and policy, emphasizing how regulatory frameworks can support technological innovation for circularity (Rodríguez et al., 2020).

Future research directions in CE should focus on addressing the barriers to implementation, such as market dynamics, consumer behavior, and regulatory challenges while continuing to explore innovative technologies and their applications in various sectors (Bocken et al., 2022; Antonov et al., 2021). By fostering collaboration across disciplines and industries, CE research can contribute to a more sustainable and resilient economic future.

CONCLUSION

Sustainability transitions within the CE are inherently complex and multifaceted, requiring the synergistic efforts of innovation, policy, governance, and socio-economic drivers. These elements are not only crucial in promoting a sustainable future but also in facilitating the gradual shift from linear economic models to more regenerative, closed-loop systems. Innovation acts as a catalyst, driving advancements in technology, materials, and processes that enable circular practices, while supportive policies and governance structures provide the framework for these innovations to be implemented at scale. Social and economic drivers, including shifts in consumer behavior and business models, further contribute to the mainstreaming of CE practices, ensuring that circularity becomes a central pillar of sustainable economic development. However, the path to successfully implementing a CE for sustainability is riddled with challenges. Overcoming technical and infrastructural barriers, addressing economic and market constraints, and resolving social and policy-related obstacles are vital for the widespread adoption of circular models. These challenges demand a coordinated and collaborative approach, involving active participation from governments, industries, and consumers alike. Only through such joint efforts can a conducive environment be created for circular practices to flourish, ultimately reshaping the economy to reduce environmental impacts while fostering long-term economic resilience.

Looking ahead, future research in the CE will continue to evolve, with a particular focus on scaling circular practices and addressing persistent challenges. A critical area of exploration will be the refinement of circular business models that are not only economically viable but also socially inclusive. This involves delving deeper into the social dimensions of circularity, such as how circular practices can enhance social equity and build

community resilience. Furthermore, the development of more precise circularity metrics and indicators will be crucial in effectively measuring the true impact of circular strategies on sustainability outcomes. Researchers are calling for the creation of more robust tools to evaluate the environmental, social, and economic benefits of circular practices comprehensively. Additionally, the role of emerging technologies, such as digital tools and data analytics, in driving and supporting circular innovation will remain a pivotal focus. These technologies will play an increasingly important role in optimizing resource flows, reducing waste, and enabling more efficient circular systems, ultimately accelerating the transition toward a more sustainable and resilient global economy.

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REFERENCES

1. Antonov, M., Hussain, A., Kamboj, N., & Podgurski, V. (2021). Circular economy approach to recycling technologies of post-consumer textile waste in estonia: a review. Proceedings of the Estonian Academy of Sciences, 70(1), 80.
2. Anuar, A., Saad, R., & Yusoff, R. Z. (2017). Operational Performance as A Mediator on the Relationship Between Lean Healthcare and Sustainability Among Private Hospitals In Malaysia Using PLS-SEM. Journal of Information System and Technology Management, 2(6), 84-104.
3. Apriantoro, M. (2024). Riding the tides of change: a bibliometric expedition on technology-enabled circular economy. Multidisciplinary Reviews, 7(5), 2024089.
4. Barna, C., Zbuchea, A., & Stănescu, S. (2023). Social economy enterprises contributing to the circular economy and the green transition in romania. Ciriec-España Revista De Economía Pública Social Y Cooperativa, (107), 47-69.
5. Bassi, F. and Guidolin, M. (2021). Resource efficiency and circular economy in european smes: investigating the role of green jobs and skills. Sustainability, 13(21), 12136.
6. Bawono, S. (2022). Circular economy role in industry and environmental sustainability: qualitative content analysis approach. Asia Pacific Journal of Management and Education, 5(3), 1-13.
7. Beccarello, M. and Foggia, G. (2022). A circularity mapping framework for urban policymaking. Journal of Politics and Law, 16(1), 11.
8. Bocken, N., Nießen, L., & Short, S. (2022). The sufficiency-based circular economy—an analysis of 150 companies. Frontiers in Sustainability, 3.
9. Bucur, L. (2023). Exploring the role of consumers in promoting a circular economy: increasing awareness and engagement. Proceedings of the International Conference on Business Excellence, 17(1), 38-47.
10. Bușu, C. and Bușu, M. (2018). Modeling the circular economy processes at the eu level using an evaluation algorithm based on shannon entropy. Processes, 6(11), 225.
11. Castro, A., Castro, J., Burgos, R., & Suqilanda, E. (2022). Circular economy and its impact on environmental sustainability. Centro Sur, 6(4).
12. Chen, W., Nalluri, V., Hung, H., Chang, M., & Lin, C. (2021). Apply dematel to analyzing key barriers to implementing the circular economy: an application for the textile sector. Applied Sciences, 11(8), 3335.
13. Ciliberto, C., Szopik-Depczyńska, K., Łuniewska, M., Ruggieri, A., & Ioppolo, G. (2021). Enabling the circular economy transition: a sustainable lean manufacturing recipe for industry 4.0. Business Strategy and the Environment, 30(7), 3255-3272.
14. Cornejo, P., Becker, J., Pagilla, K., Mo, W., Zhang, Q., Mihelcic, J., & Rosso, D. (2019). Sustainability metrics for assessing water resource recovery facilities of the future. *Water Environment Research*, *91*(1), 45-53.
15. Corsini, F., Laurenti, R., Meinherz, F., Appio, F., & Mora, L. (2019). The advent of practice theories in research on sustainable consumption: past, current and future directions of the field. Sustainability, 11(2), 341.

16. Dewick, P., Bengtsson, M., Cohen, M., Sarkis, J., & Schröder, P. (2020). Circular economy finance: clear winner or risky proposition? Journal of Industrial Ecology, 24(6), 1192-1200.
17. Didenko, N., Klochkov, Y., & Skripnuk, D. (2018). Ecological criteria for comparing linear and circular economies. Resources, 7(3), 48.
18. Feng, K. and Lam, C. (2021). An overview of circular economy in china: how the current challenges shape the plans for the future. Chinese Economy, 54(5), 355-371.
19. Garcés-Ayerbe, C., Torres, P., Suárez-Perales, I., & Hiz, D. (2019). Is it possible to change from a linear to a circular economy? an overview of opportunities and barriers for european small and medium-sized enterprise companies. International Journal of Environmental Research and Public Health, 16(5), 851.
20. Geissdoerfer, M., Savaget, P., Bocken, N., & Hultink, E. (2017). The circular economy – a new sustainability paradigm? Journal of Cleaner Production, 143, 757-768.
21. 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.
22. Gopan, S. (2023). Indian automotive supply chains: barriers to circular economy for sustainable development. Management Decision, 61(11), 3589-3609.
23. Gottardo, S., Mech, A., Drbohlavová, J., Małyska, A., Bøwadt, S., Sintes, J., … & Rauscher, H. (2021). Towards safe and sustainable innovation in nanotechnology: state-of-play for smart nanomaterials. Nanoimpact, 21, 100297.
24. Guo, Y., Chertow, M., & Chen, L. (2017). Exploring greenhouse gas-mitigation strategies in chinese eco-industrial parks by targeting energy infrastructure stocks. Journal of Industrial Ecology, 22(1), 106-120.
25. He, X. and Li, B. (2023). A study on the influence of green industrial policy on urban green development: based on the empirical data of ecological industrial park pilot construction. Sustainability, 15(13), 10065.
26. Hira, A., Pacini, H., Attafuah-Wadee, K., & Hassall, J. (2022). Sustainable manufacturing and environmental pollution programme (smep): a circular economy experiment in the global south. Journal of Developing Societies, 38(3), 287-309.
27. Hu, Y., He, X., & Poustie, M. (2018). Can legislation promote a circular economy? a material flow-based evaluation of the circular degree of the chinese economy. Sustainability, 10(4), 990.
28. Iacovidou, E., Busch, J., Hahladakis, J., Baxter, H., Ng, K., & Herbert, B. (2017). A parameter selection framework for sustainability assessment. *Sustainability*, *9*(9), 1497.
29. Idrus, R. (2024). Analysis of the relationship between the implementation of circular economy principles and financial inclusion to poverty alleviation in Indonesia. West Science Social and Humanities Studies, 02(04), 631-640.
30. Insanic, I., & Gadde, L. (2014). Organizing product recovery in industrial networks. *International Journal of Physical Distribution & Logistics Management*, *44*(4), 260-282.
31. Jakubelskas, U. (2023). Circular economy practices as a tool for sustainable development in the context of renewable energy: what are the opportunities for the eu?. Oeconomia Copernicana, 14(3), 833-859.
32. Kehrein, P., van Loosdrecht, M., Osseweijer, P., Garfí, M., Dewulf, J., & Posada, J. (2020). A critical review of resource recovery from municipal wastewater treatment plants – market supply potentials, technologies and bottlenecks. *Environmental Science: Water Research & Technology*, *6*(4), 877-910.
33. Kio, P., Anumba, C., & Ali, A. (2022). Circular economy trends – potential role of emerging technologies. Iop Conference Series Earth and Environmental Science, 1101(6), 062005.
34. 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 EU. Ecological Economics, 150, 264-272.
35. Kehrein, P., Loosdrecht, M. V., Osseweijer, P., Garfí, M., Dewulf, J., & Posada, J. (2020). A critical review of resource recovery from municipal wastewater treatment plants – market supply potentials, technologies and bottlenecks. Environmental Science: Water Research & Technology, 6, 877-910.
36. Koval, V., Kryshtal, H., Udovychenko, V., Soloviova, O., Фротер, О., KOKORINA, V., … & Veretin, L. (2023). Review of mineral resource management in a circular economy infrastructure. Mining of Mineral Deposits, 17(2), 61-70.
37. Lahti, T., Wincent, J., & Parida, V. (2018). A definition and theoretical review of the circular economy, value creation, and sustainable business models: where are we now and where should research move in

the future? Sustainability, 10(8), 2799.
38. Lakatos, E. S., Yong, G., Szilagyi, A., Clinci, D. S., Georgescu, L., Iticescu, C., & Cioca L-I (2021). Conceptualizing core aspects on circular economy in cities. Sustainability, 13(14), 7549.
39. Levicky, M., Urbaniko.va, M., & Dragunova, M. (2021). Progress in the transition of the circular economy in slovakia and the european union. Journal of Business, 10(1), 44-51.
40. Levicky, M., Krajcovic, M., & Dvorak, J. (2021). Progress in the transition of the circular economy in Slovakia and the EU. Journal of Business, 10(1), 44-51.
41. Lewandowska, A., Rogatka, K., & Lopata, E. (2022). Social awareness of the circular economy as an integral part of sustainable development. observations from Poland. Civil and Environmental Engineering Reports, 32(2), 132-153.
42. Mang, P. and Reed, B. (2017). Regenerative development and design., 1-28.
43. Mashovic, A., Ignjatovic, J., & Kisin, J. (2022). Circular economy as an imperative of sustainable development in north macedonia and serbia. Ecologica, 29(106), 169-177.
44. Mathews, J. and Tan, H. (2011). Progress toward a circular economy in china. Journal of Industrial Ecology, 15(3), 435-457.
45. Meng, X. (2023). Integration of digital twin and circular economy in the construction industry. Sustainability, 15(17), 13186.
46. Mihajlov, A., Mladenović, A., & Jovanovic, F. (2021). Country in transition (serbia) case: circular economy starts from waste management. Environmental Research and Technology, 4(1), 83-88.
47. Millar, N., McLaughlin, E., & Börger, T. (2019). The circular economy: swings and roundabouts?. Ecological Economics, 158, 11-19.
48. Motloch, J. (1995). Regenerative design for sustainable development. Landscape and Urban Planning, 32(3), 198-201.
49. Murray, A., Skene, K., & Haynes, K. (2015). The circular economy: an interdisciplinary exploration of the concept and application in a global context. Journal of Business Ethics, 140(3), 369-380.
50. Mykkänen, J. and Repo, P. (2021). Consumer perspectives on arranging circular economy in finland. Sustainability Science Practice and Policy, 17(1), 349-361.
51. Nandha Gopan, N. S., & Balaji, M. (2023). Indian automotive supply chains: barriers to circular economy for sustainable development. Management Decision, 61(11), 3589-3609.
52. Ocolișanu, A., Dobrotă, G., & Agârbiceanu, M. (2022). The implications of the circular economy on sustainable economic growth. Management of Sustainable Development, 14(1), 16-21.
53. Oyeranmi, S. G., & Navickas , V.(2023). The circular economy transition in the European union. Journal of Management, 39(2), 97-103.
54. Ozili, P. (2021). Circular economy, banks, and other financial institutions: what's in it for them? Circular Economy and Sustainability, 1(3), 787-798.
55. 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.
56. Pesce, M., Tamai, I., Guo, D., Critto, A., Brombal, D., Wang, X., Cheng, H. & Marcomini, A. (2020). Circular economy in china: translating principles into practice. Sustainability, 12(3), 832.
57. Pieroni, M., Pigosso, D., & McAloone, T. (2018). Exploring the synergistic relationships of circular business model development and product design. In Proceedings of the Design 2018 15th International Design Conference, 2715-2726.
58. Plessis, C. (2012). Towards a regenerative paradigm for the built environment. Building Research & Information, 40(1), 7-22.
59. Pollard, J., Osmani, M., Cole, C., Grubnic, S., Colwill, J., & Díaz, A. (2022). Developing and applying circularity indicators for the electrical and electronic sector: a product lifecycle approach. Sustainability, 14(3), 1154.
60. Qin, M., & He, Z. (2017). Resource recovery by osmotic bioelectrochemical systems towards sustainable wastewater treatment. *Environmental Science: Water Research & Technology*, *3*(4), 583-592.
61. Rada, E., Cioca, L., & Ionescu, G. (2017). Energy recovery from municipal solid waste in eu: proposals to assess the management performance under a circular economy perspective. Matec Web of Conferences, 121, 05006.
62. Reddy, V. (2023). Waste to wealth generation: Innovative methodologies in resource utilization and minimization in circular economy. *E3S Web of Conferences*, *453*, 01035.

63. Robles, Á., Serralta, J., Martí, N., Ferrer, J., & Seco, A. (2021). Anaerobic membrane bioreactors for resource recovery from municipal wastewater: A comprehensive review of recent advances. *Environmental Science: Water Research & Technology*, *7*(11), 1944-1965.
64. 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.
65. Romero, C., Castro, D., Ortíz, J., Khalaf, O., & Vargas, M. (2021). Synergy between circular economy and industry 4.0: a literature review. Sustainability, 13(8), 4331.
66. Romero-Hernández, O. and Romero, S. (2018). Maximizing the value of waste: from waste management to the circular economy. Thunderbird International Business Review, 60(5), 757-764.
67. Ruiz–Real, J., Uribe-Toril, J., Valenciano, J., & Gázquez–Abad, J. (2018). Worldwide research on circular economy and environment: a bibliometric analysis. International Journal of Environmental Research and Public Health, 15(12), 2699.
68. Saeed, S., Arshad, M. Y., & Ahmed, A. S. (2023). Advancing circular economy in industrial chemistry and environmental engineering: Principles, alignment with United Nations sustainable development goals, and pathways to implementation. European Journal of Chemistry, 14(3), 414–428.
69. Salleh, H., Ying, C., Hanid, M., Abdul-Samad, Z., Sabli, N., & Khuzzan, S. (2022). Development of guidance for the adoption of circular economy in construction and demolition waste management. Planning Malaysia, 20.
70. Shaharudin, M. R., Hamid, N., Abdullah, D., Ahmad, N., Hassam, S. F., & Fauzi, N. H. H. A. (2022a). Factors affecting social sustainability performance amongst Malaysian manufacturing companies. International Journal of Business and Society, 23(3), 1874-1887.
71. Shaharudin, M. R., Mohamad Mokhtar, A. R., Wararatchai, P., & Legino, R. (2022b). Circular Supply Chain Management and Circular Economy: A conceptual model. Environment-Behaviour Proceedings Journal, 7(SI7), 31–37.
72. Shaharudin, M. R., Zainoddin, A. I., Abdullah, D., Hotrawaisaya, C., H. Soonthornpipit, H., & Norddin, N. (2020). Factors that influence the green purchasing practices among suppliers of electrical components. AIP Conference Proceedings 5 October 2018, 1, 020066.
73. Shirazi, M. M. A. (2023). Resource recovery for sustainable development and circular economy. *Journal of Resource Recovery*, *1*(1011), 1-2.
74. Siregar, M. (2023). Application of circular economy in manufacturing industry in indonesia. Amca Journal of Community Development, 3(1), 19-24.
75. Skvarciany, V., Lapinskaitė, I., & Volskytė, G. (2021). Circular economy as assistance for sustainable development in oecd countries. Oeconomia Copernicana, 12(1), 11-34.
76. Stoica, G. and Stoian, M. (2022). Durability, circularity and sustainability in the food market – bibliometric analysis. Proceedings of the International Conference on Business Excellence, 16(1), 456-465.
77. Suchek, N., Fernandes, C., Kraus, S., Filser, M., & Sjögrén, H. (2021). Innovation and the circular economy: a systematic literature review. Business Strategy and the Environment, 30(8), 3686-3702.
78. Supanut, A. (2024). Circular economy strategies in practice: a qualitative examination of industry adaptation and innovation. Revista De Gestão Social E Ambiental, 18(3), e06723.
79. Szilagyi, A., Cioca, L., Bacali, L., Lakatos, E., & Bîrgovan, A. (2022). Consumers in the circular economy: a path analysis of the underlying factors of purchasing behaviour. International Journal of Environmental Research and Public Health, 19(18), 11333.
80. Ting, L. S., Zailani, S., Sidek, N. Z. M., & Shaharudin, M. R. (2023). Motivators and barriers of circular economy business model adoption and its impact on sustainable production in Malaysia. Environment Development and Sustainability, 26(7), 17551-17578.
81. Trică, C., Bănacu, C., & Buşu, M. (2019). Environmental factors and sustainability of the circular economy model at the european union level. Sustainability, 11(4), 1114.
82. Tu, J., Lo, T., Sie, Y., & Kao, T. (2021). Key factors for involvement degree and perceived value in consumers' purchase intention in unpacked stores. Sustainability, 13(22), 12563.
83. Vanhamäki, S., Rinkinen, S., & Manskinen, K. (2021). Adapting a circular economy in regional strategies of the european union. Sustainability, 13(3), 1518.
84. Viglioglia, M., Giovanardi, M., Pollo, R., & Peruccio, P. (2021). Smart district and circular economy: the role of ict solutions in promoting circular cities. Sustainability, 13(21), 11732.

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85. Wei, W., De, X., & Wan, L. (2022). The analysis of optimized path selection for management mode of coastal regional circular economy based on fuzzy decision algorithm. Expert Systems, 41(5).
86. Zhu, J., Fan, C., Shi, H., & Shi, L. (2018). Efforts for a circular economy in china: a comprehensive review of policies. Journal of Industrial Ecology, 23(1), 110-118.
87. Zink, T. and Geyer, R. (2017). Circular economy rebound. Journal of Industrial Ecology, 21(3), 593-602.