

Innovation and Entrepreneurship in the Circular Economy: A Systematic Review

Inovasi dan Kewirausahaan dalam Ekonomi Sirkular: Tinjauan Sistematis

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ABSTRACT

The circular economy is an important strategic approach in promoting global sustainability by separating economic growth from environmental degradation. The transition to a circular economy leverages digital technology to increase resource efficiency, reduce waste and encourage collaboration among stakeholders. This research aims to explore the role of digital technology in supporting entrepreneurial innovation in the context of a circular economy. This research uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method to collect and analyze relevant literature from reputable databases such as Scopus, Web of Science, and ScienceDirect. The research results show that digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), and big data analysis, have a significant role in facilitating entrepreneurial innovation and accelerating the transition to a circular economy. The implications of this research are important for policy makers and business practitioners in designing more sustainable and efficient strategies. This research also makes an academic contribution by filling the gap in the literature regarding the interaction between digital technology and entrepreneurial innovation in the circular economy, as well as providing practical recommendations for implementation in various industrial sectors.

Keywords: Circular Economy, Digital Technology, Entrepreneurial Innovation, Sustainable Business Models, Internet of Things, Artificial Intelligence, Big Data.

ABSTRAK

Ekonomi sirkular merupakan pendekatan strategis yang penting dalam mendorong keberlanjutan global dengan memisahkan pertumbuhan ekonomi dari degradasi lingkungan. Transisi menuju ekonomi sirkular memanfaatkan teknologi digital untuk meningkatkan efisiensi sumber daya, mengurangi limbah, dan mendorong kolaborasi di antara para pemangku kepentingan. Penelitian ini bertujuan untuk mengeksplorasi peran teknologi digital dalam mendukung inovasi kewirausahaan dalam konteks ekonomi sirkular. Penelitian ini menggunakan metode PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) untuk mengumpulkan dan menganalisis literatur yang relevan dari database bereputasi seperti Scopus, Web of Science, dan ScienceDirect. Hasil penelitian menunjukkan bahwa teknologi digital, seperti Internet of Things (IoT), kecerdasan buatan (AI), dan analisis data besar (big data), memiliki peran signifikan dalam memfasilitasi inovasi kewirausahaan dan mempercepat transisi menuju ekonomi sirkular. Implikasi penelitian ini penting bagi pembuat kebijakan dan praktisi bisnis dalam merancang strategi yang lebih berkelanjutan dan efisien. Penelitian ini juga memberikan kontribusi akademis dengan mengisi gap dalam literatur terkait interaksi antara teknologi digital dan inovasi kewirausahaan dalam ekonomi sirkular, serta menyediakan rekomendasi praktis untuk implementasi di berbagai sektor industri.

Kata Kunci: Ekonomi Sirkular, Teknologi Digital, Inovasi Kewirausahaan, Model Bisnis Berkelanjutan, Internet of Things, Kecerdasan Buatan, Big Data.

1. Introduction

The circular economy has an important role in the context of global sustainability by providing a systemic approach to economic activity that aims to separate economic growth from environmental degradation (Voulvoulis, 2022). The transition to a circular economy can increase global resource efficiency in consumption and production, thereby contributing to

sustainable development (Voulvoulis, 2022). This transition involves extending the useful life of products, reusing materials, and promoting a zero-waste economic system (Panwar & Niesten, 2022). Integrating circular economy principles into global supply chain strategies can strengthen sustainability and resilience in facing environmental challenges (Solomon, 2024).

The promotion of the circular economy is seen as a promising trend for safeguarding the global ecological system and driving industrial innovation (Hu et al., 2022). This is increasingly highlighted in political agendas, such as the European Circular Economy Package and the New Circular Economy Action Plan, which are in line with the 2030 Sustainable Development Goals (Luz, 2022). Circular economy initiatives are important for achieving the 2030 Agenda for Sustainable Development and meeting the Sustainable Development Goals (Steinfatt, 2020).

In addition, the circular economy is recognized as a tool that provides solutions to some of the most critical global challenges related to sustainable development (Moshkal et al., 2022). The circular economy is considered a fundamental pillar of sustainable development, leading to resource efficiency, environmental benefits and economic viability (Ghoochkanloo, 2020). A circular economy model is indispensable for achieving sustainable development goals and encouraging closed systems that extend the life cycle of materials and resources (Nemesh, 2022).

In conclusion, a circular economy is critical to advancing global sustainability efforts by promoting resource efficiency, reducing waste, and fostering economic, social, and environmental balance. Its integration into various sectors and supply chain strategies is critical to achieving long-term sustainability goals and overcoming the challenges posed by environmental degradation and climate change.

The rapid development of digital technology has had a significant impact on the business and entrepreneurship sectors, especially in the context of innovation and entrepreneurship in the circular economy. Digital technology plays a crucial role in advancing the circular economy by offering new ways to optimize resource use, increase efficiency, and encourage collaboration among stakeholders (Zulkifli, 2024). The adaptation of digital technology in current business models and the continued promotion of innovative entrepreneurship supports the transition from a linear economy to a circular economy, while opening up new study opportunities (Manea et al., 2021). In addition, the digital revolution which covers various aspects of life has had a profound impact on the economy both globally and nationally, emphasizing the importance of digital technology in driving economic change (Murat, 2023).

In the realm of entrepreneurship, the digital transformation of businesses is becoming increasingly essential to achieving success, with the application of digital technologies serving as a key determinant of organizational success today and in the future (Popović et al., 2022). The integration of digital technologies into business processes not only facilitates management activities but also increases market recognition, demonstrating the critical role of digitalization in modern business operations (Martinčević & Kozina, 2021). Furthermore, the ongoing digital transformation in the economy, driven by the introduction of digital technologies, is directly affecting entrepreneurship by overhauling various economic sectors (Arsakaev, 2021).

In the context of the circular economy, data analysis, digital technologies and competitive intelligence are recognized as important drivers that advance the circular economy, leading to changes in the development of social entrepreneurship (Ilić et al., 2022). Circular business model experiments were also identified as a valuable approach for companies aiming to transition towards a circular economy, emphasizing the importance of innovative strategies in achieving circularity in resource utilization (Konietzko et al., 2020). In addition, eco-innovation is recognized as an important mechanism that facilitates the transition from a linear economy to a circular economy, especially in industries such as automotive, where

eco-innovation plays a significant role in aligning production processes with circular economy principles (Maldonado-Guzmán et al ., 2020).

In conclusion, the intersection of digital technology, entrepreneurship and the circular economy presents a dynamic landscape where innovation, sustainability and efficiency come together to drive economic development and social change. Adopting digital transformation, encouraging sustainable entrepreneurship, and promoting circular economy principles are essential components for creating a more resilient and environmentally conscious business environment.

The implementation of a circular economy faces various challenges in various industrial sectors. These difficulties include limited infrastructure, regulatory constraints, as well as a lack of awareness and knowledge regarding circular practices among business actors. Apart from that, the role of digital technology in supporting circular entrepreneurial innovation is not yet optimal. Digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), and big data analysis, have great potential to optimize resource use and improve operational efficiency. However, the use of this technology in the context of a circular economy is still not fully realized, causing a gap between technological capabilities and its application in circular entrepreneurship practices.

This research seeks to answer the question: "What is the role of digital technology in facilitating entrepreneurial innovation in a circular economy?" This question is important to understand the extent to which digital technology can support and accelerate innovation in circular economy-oriented business models. The focus of this research will explore various applications of digital technology and their impact on sustainability and efficiency in the entrepreneurial process.

The existing literature shows a lack of studies that deeply explore the interactions between digital technologies and entrepreneurial innovation in the circular economy. Many studies focus on the technical aspects of digital technologies or on circular business models separately, but few link the two in a comprehensive way. This gap shows the need for research that is able to integrate these two aspects to provide a more holistic understanding of how digital technology can be used to facilitate and accelerate circular entrepreneurial innovation.

The urgent need to understand how digital technologies can accelerate the transition to a circular economy is increasing along with global pressure to achieve sustainable development goals. In this context, research that is able to explain the role of digital technology in accelerating innovation and implementing circular business models is very important. This research is not only academically relevant but also has significant practical implications for entrepreneurs and policy makers in designing more sustainable business strategies.

This research will provide new insights into the specific role of digital technology in driving entrepreneurial innovation in the circular economy. By exploring how digital technology can be applied to increase efficiency, reduce waste, and create added value in circular business models, this research is expected to fill the gap in existing literature. The uniqueness of this research lies in its approach which integrates digital technology with the concept of circular entrepreneurship to produce an innovative and sustainable business model.

It is hoped that this research can provide practical recommendations for entrepreneurs and policy makers in adopting digital technology to support circular entrepreneurial innovation. In addition, this research will also contribute to new literature in the field of entrepreneurial innovation and digital technology, by providing a comprehensive and evidence-based analysis of how digital technology can be used to overcome challenges in implementing a circular economy. Thus, this research has the potential to have a significant impact in encouraging more sustainable and efficient business practices.

2. Research Methods

2.1 Collection of Articles

The collection of articles in this research was carried out using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method. PRISMA is a systematic and transparent method for selecting and evaluating relevant literature, thereby ensuring that the research conducted has a solid and reliable basis.

2.2 Reputable International Databases

Articles are collected from several reputable databases to ensure the quality and credibility of the literature used. The databases selected included Scopus, Web of Science, and ScienceDirect. These three databases are widely known in the academic community as sources providing high quality peer-reviewed articles.

2.3 Keywords Used

To search for articles relevant to the research topic, several specific keywords were used, including: "Circular Economy," "Digital Technology," "Entrepreneurship Innovation," "Sustainable Business Models," "IoT," "AI," "Blockchain," and "Big Data." These keywords were chosen because they cover various aspects related to the circular economy, digital technology and entrepreneurial innovation.

2.4 Number of Articles Retrieved

The article filtering process using the PRISMA technique starts from the identification stage, where all relevant articles are identified based on predetermined keywords. Next, these articles go through a screening stage to evaluate their relevance and quality, before finally entering the inclusion stage where articles that meet the criteria are included in the final analysis.

2.5 Article Inclusion and Exclusion Techniques

To ensure only the most relevant and high-quality articles were included in the study, the following inclusion and exclusion criteria were used:

1. **Inclusion Criteria:** Peer-reviewed articles, high relevance to the research topic, publications within the last 5 years, and articles written in English.
2. **Exclusion Criteria:** Articles with weak methodology, low relevance to the research topic, articles that are duplicates, and publications in non-reputable journals.

Through this process, it is hoped that only the most relevant and high-quality articles will be used in the analysis, so that the research results can make a significant contribution to existing literature and real practice in the field of circular economy and entrepreneurial innovation.

3. Results and Discussions

3.1. Basic Concepts and Theories

3.1.1. Circular Economy

A circular economy is an economic system that aims to move away from the traditional linear model of production, consumption and disposal towards a more sustainable approach (Suzanne et al., 2020). The focus is on creating environmental quality, economic prosperity, and social equality for current and future generations (Suzanne et al., 2020). This transition involves rethinking value chains, developing new business models, and utilizing technology to process industrial waste efficiently (Трушкіна & Prokopyshyn, 2021; Caprian et al., 2023). Circular economy models emphasize remanufacturing, reusing, and recycling products and materials to extend their useful life, in contrast to the linear economy's focus on disposal (Esparragoza &

Mesa, 2019). The circular economy is restorative and regenerative, aiming to maintain the usefulness and value of products and resources over time (Diéguez-Santana et al., 2021; Morsetto, 2020).

Implementation of a circular economy provides various benefits, such as resource savings, improved environmental outcomes, better human health, and economic diversification (Steinfatt, 2020). It offers a sustainable economic model amidst limited resources and environmental challenges ("Promotion and application of circular economy models", 2023). The circular economy is seen as a solution to the environmental consequences of mass production and fast consumption, promoting sustainable development and addressing issues of environmental degradation and social equality (Norouzi, 2022; Millar et al., 2019). Additionally, the circular economy provides opportunities for businesses to create value through circular strategies and practices, leveraging digital technologies throughout the product life cycle (Bressanelli et al., 2022).

However, implementing a circular economy is not without challenges. This requires a logistics paradigm shift, the development of new business models, and the incorporation of digital technologies (Caprian et al., 2023). Barriers such as lack of awareness, regulatory constraints, and the need for significant upfront investment can hinder the adoption of circular economy practices (Dissanayake & Weerasinghe, 2021). Furthermore, although circular economy models are increasingly recognized as a more sustainable alternative to linear economies, further research, clear definitions and frameworks are still needed to fully realize their potential (Farooque et al., 2019; Álvarez-Risco et al., 2021).

In conclusion, the circular economy offers a promising approach to sustainable development by promoting resource efficiency, environmental protection and economic growth. Although there are challenges in implementation, the benefits of the transition to a circular economy are significant in creating a more sustainable and resilient economic system.

3.1.2. Digital Technology

Digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and Blockchain play an important role in the modern world of business and entrepreneurship, facilitating innovation and driving a circular economy. Blockchain technology uses cryptography to ensure secure and transparent transactions, enabling seamless integration with IoT and cloud computing (Benz et al., 2021). Blockchain provides decentralized and traceable data exchange, increasing security and efficiency across multiple domains (Hussain et al., 2022), while also serving as an integrated solution that combines cryptography, distributed consistency protocols, and other network security (Zou et al., 2020).

Entrepreneurship is increasingly adopting digital platforms, which have reduced operational costs, opened new business opportunities, and expanded engagement with customers (Akhter et al., 2022). As a distributed ledger technology, blockchain guarantees data immutability through cryptographic blocks stored in various network nodes (Marikyan et al., 2021), fostering trust through transparency and audit trails in data, goods, services and financial transactions (Boison & Antwi -Boampong, 2020).

Blockchain technology offers various advantages for innovation and entrepreneurship in a circular economy, including decentralized data storage, direct data transmission, consensus mechanisms, and encryption algorithms (Wang, 2021). The integration of this technology in business models supports innovative corporate governance by ensuring secure and transparent transaction records and efficient data management (Wang, 2021), expanding its application from the financial sector to sectors such as healthcare, where blockchain facilitates decentralized transaction data management (Elghoul, 2021). Overall, digital technologies such as blockchain, IoT, and AI are becoming key drivers of innovation in business and entrepreneurship, which is critical to advancing circular economy principles. The secure and

transparent nature of blockchain technology is revolutionizing data management and transaction processes, creating new opportunities for businesses to thrive in this digital era.

3.1.3. Entrepreneurial Innovation

Entrepreneurial innovation in the context of a circular economy involves the creation of new products, services, or business models by entrepreneurial individuals or organizations to address market needs or add unique value (Fleischmann, 2019). Several factors influence entrepreneurial innovation in a circular economy, including design-led innovation, eco-innovation, sustainable entrepreneurship, and digital technology integration (Fleischmann, 2019; Maldonado-Guzmán et al., 2020; Manea et al., 2021). Design-led innovation is essential to drive the business model transformation required in the transition to a circular economy (Fleischmann, 2019). Eco-innovation, especially in products, processes and management, plays an important role in moving from a linear economy to a circular economy (Maldonado-Guzmán et al., 2020). Sustainable innovative entrepreneurship, combined with the adoption of digital technologies in business models, supports the transition to a circular economy and opens up new opportunities for research and development (Manea et al., 2021).

The adoption of circular economy principles aims to reduce the economic costs of resources and waste, promoting the development of environmentally friendly products and business models (Stankevičienė et al., 2020). Collaboration between individuals who have an entrepreneurial spirit, based on a shared vision, enthusiasm and credible propositions, is very important to encourage circularly oriented innovation (Brown et al., 2019). Leveraging entrepreneurial methods, as demonstrated in the reuse of wood waste, can further encourage innovation in the circular economy, creating a positive cycle of innovation (Klerk et al., 2022).

In summary, entrepreneurial innovation in a circular economy is influenced by various factors such as design-led innovation, eco-innovation, sustainable entrepreneurship, digital technology, and collaborative efforts. By embracing these factors and integrating circular economy principles, entrepreneurs can drive innovation, build sustainable business models, and contribute to the transition to a more resource-efficient and environmentally friendly economy.

3.2. Digital Technology and Circular Economy

3.2.1. IoT (Internet of Things)

The integration of digital technology, especially the Internet of Things (IoT), plays a crucial role in advancing the circular economy by increasing resource efficiency and productivity (Kio et al., 2022). IoT, along with other technologies such as blockchain, artificial intelligence (AI), and big data analytics, is becoming an important tool that accelerates the implementation of circular economy principles in various sectors including buildings, manufacturing, and supply chains (Trubina, 2024). Research shows that IoT enables effective monitoring, tracking and data collection, facilitating the adoption of circular strategies and encouraging collaboration in a circular economy (Schöggel, 2023; Ingemarsdotter et al., 2019).

In the context of Industry 4.0 and the circular economy, IoT is recognized as a basic technology that supports connectivity and intelligence in manufacturing systems (Maria et al., 2022). Its application in smart cities, supported by technologies such as LoRa, makes a significant contribution to circular economy initiatives and improves decision-making processes (Andrade & Yoo, 2019). Additionally, IoT plays an important role in sustainable supply chain management in the manufacturing sector, underscoring the importance for companies to adopt IoT and other innovative technologies to effectively achieve sustainability goals (Yang et al., 2021).

IoT technology not only improves operational efficiency but also promotes environmental sustainability by encouraging businesses to adopt more environmentally friendly and efficient practices (Sun & Wang, 2022). By leveraging IoT and big data,

organizations can gather real-time customer insights to improve services and develop innovative solutions (Wang, 2019). In addition, the integration of AI and IoT technologies with life cycle assessment (LCA) is an important step towards achieving a sustainable circular economy (Sofian, 2023). Overall, IoT serves as a foundational technology that supports the circular economy through real-time monitoring, data collection, and intelligent decision making across various industries. The integration of IoT with other digital technologies is critical to driving sustainability, increasing resource efficiency, and facilitating collaboration in a circular economy.

3.2.2. Artificial Intelligence (AI)

Artificial Intelligence (AI) is increasingly recognized for its role in increasing efficiency and sustainability in the circular economy. By leveraging AI technology, businesses can optimize processes such as reverse logistics, leading to improved resource utilization and reduced waste (Wilson et al., 2021). The integration of AI in supply chains drives sustainable practices, contributing to broader sustainability goals (Oyewole, 2024). Additionally, AI facilitates the development of circular entrepreneurial innovation by enabling opportunity identification and process improvement (Wang et al., 2022).

Circular entrepreneurs are increasingly recognizing the importance of AI in driving sustainability transformation (Henry et al., 2022). The emergence of circular business models is expected to be in line with the iterative practices common in circular product manufacturing, which encourage innovation and efficiency ("Entrepreneurship as Practice", 2022). In addition, the digitalization of technology, including AI, is overhauling traditional business paradigms and offering new opportunities for success in entrepreneurship (Usman, 2024).

AI not only improves operational efficiency but also contributes to environmental sustainability by increasing resource efficiency in manufacturing processes (Waltersmann et al., 2021). Additionally, the application of AI in sustainable supply chain finance is revolutionizing the business ecosystem, highlighting the importance of technological advances in driving sustainable practices (Olan et al., 2024). AI governance in the network industry relies on access to big data, highlighting the intertwined relationship between AI development and data sharing (Knieps, 2023). In conclusion, the synergy between AI and circular economy principles offers a promising path to promote sustainability and innovation. By leveraging AI technology, entrepreneurs can increase efficiency, optimize resource utilization, and encourage sustainable practices in their operations.

3.2.3. Blockchain

Blockchain technology can indeed provide significant benefits in promoting transparency, traceability and sustainability in circular supply chains. By leveraging blockchain, organizations can increase visibility, build trust among network partners, and simplify processes in accordance with circular economy principles (Panghal et al., 2022). The decentralized nature of blockchain, along with its smart contract capabilities, enables the secure and transparent exchange of information, encouraging a more sustainable approach to supply chain management (Corsini et al., 2023).

Examples of blockchain applications for transparency and sustainability in circular supply chains include improving traceability of materials among network partners in manufacturing (Tonnaer, 2023), redesigning supply chains for co-leasing to redistribute inventory regionally (Nandi et al., 2021), and enabling closed supply chain systems as well as reverse omnichannel solutions (Giovanni, 2022). These applications demonstrate how blockchain technology can facilitate the transition to a circular economy by increasing resource efficiency, reducing waste, and promoting sustainable practices throughout the supply chain.

Overall, blockchain technology plays an important role in advancing the circular economy agenda by providing a digital infrastructure that supports the efficient and

transparent exchange of goods and information, ultimately contributing to a more sustainable and environmentally friendly business ecosystem.

3.2.4. Big Data dan Analytics

Big data plays a significant role in driving innovation in the circular economy by enabling businesses to analyze large amounts of data to make informed decisions and optimize processes. Big data applications in circular innovation cover areas such as sustainable manufacturing, supply chain practices and sustainable development. Industry 4.0 technologies, including big data analytics powered by artificial intelligence, have been identified as a key driver for improving sustainable manufacturing and circular economy capabilities (Bag & Pretorius, 2020). By leveraging big data, companies can increase resource efficiency, reduce waste, and improve overall sustainability performance.

Furthermore, the integration of big data in supply chain practices within a circular economy framework extends the lifetime of materials, promoting sustainability throughout the supply chain process (Fenisa, 2024). This approach aims to minimize waste and maximize resource utilization, in line with circular economy principles. The relationship between big data, sustainable supply chain management and corporate performance is moderated by circular economy thinking, which focuses on promoting the circularity of resources to reduce waste and emissions in supply chains (Le, 2022). This highlights the importance of integrating circular economy principles into the utilization of big data for sustainable business practices.

Additionally, the use of big data has been linked to the promotion of product and process innovation, emphasizing the important role of exploiting information obtained through big data for innovative progress (Tunc-Abubakar et al., 2022). It shows how big data can drive innovation in circular economy initiatives by providing valuable insights and supporting decision-making processes. In conclusion, the strategic application of big data in circular innovation not only improves operational efficiency and sustainability but also encourages a culture of continuous improvement and innovation in businesses operating within a circular economy framework.

3.3. Entrepreneurial Innovation in the Circular Economy

3.3.1. Innovative Business Model

In the context of encouraging entrepreneurial innovation in a circular economy, it is crucial to explore business models that are aligned with the principles of sustainability and resource efficiency. Circular business models play a crucial role in promoting a regenerative economic system by emphasizing material reduction, reuse and recycling. Several studies highlight the importance of digital innovation and circular business model innovation as key drivers of the circular economy (Huynh, 2021). These models require a change in mindset towards innovative approaches that support sustainability goals ("Polish perceptions on changing the world with sustainable entrepreneurship", 2021).

Successful startups often demonstrate the practical application of circular business models. These startups typically demonstrate operational excellence, technological innovation, and business models that align with circular economy principles (Sehnem et al., 2022). Various tools and approaches for circular business model innovation are starting to emerge to support organizations in the transition towards circularity (Bocken et al., 2019). Business model innovation is identified as a strategic lever that can help businesses adapt to market conditions and encourage sustainable practices (Lauten-Weiss & Ramesohl, 2021).

Furthermore, the adoption of circular business models is critical for the transition towards a circular economy and sustainable value creation (Ghoochanloo, 2020). Companies are encouraged to experiment with their business models to align with circular economy principles and encourage innovation (Konietzko et al., 2020). Additionally, managerial commitment is identified as a critical factor in designing effective circular economy business

models (Ünal et al., 2019). In conclusion, the synthesis of these references emphasizes the importance of innovative business models in driving entrepreneurial success in the circular economy. By adopting a circular business model, startups can not only contribute to environmental sustainability but also create value through resource optimization and innovation.

3.3.2. Encouraging and Inhibiting Factors

In the realm of entrepreneurial innovation in a circular economy, various internal and external factors play an important role. The transition from a linear economy to a circular economy involves integrating digital technologies into existing business models, encouraging sustainable innovative entrepreneurship, and fostering a symbiotic entrepreneurial ecosystem (Manea et al., 2021; Oliveira et al., 2021). Collaboration between entrepreneurially minded individuals who share a vision and enthusiasm for the circular economy is essential (Brown et al., 2019). In addition, the interaction of innovation networks, frugal innovation, and organizational readiness is very important to encourage innovation in organizations operating in the circular economy (Yousaf et al., 2022). Various factors such as human capital, sustainable development perspective, maintaining resource value, business innovation, and redesign of processes and material cycles also influence the circular economy (Safariyani, 2023).

Digital technologies, data analytics and competitive intelligence are identified as key drivers of the circular economy, driving progress towards social entrepreneurship (Ilić et al., 2022). The adoption of diverse business models, including for frugal innovation and circular economy, has been observed as a result of digital transformation in business model innovation (Vaska et al., 2021). Furthermore, design-led innovation is recognized as a fundamental driver in the transition to a circular economy, providing a methodology for driving important business model transformations (Fleischmann, 2019).

Innovation in the circular economy is critical for sustainable development, with eco-innovation playing a significant role in the shift from a linear to a circular economy in sectors such as the automotive industry (Maldonado-Guzmán et al., 2020). Circular entrepreneurship is identified as a key element in the transition process, with grassroots circular entrepreneurs potentially playing a crucial role in advancing the circular economy (Henry et al., 2022). Additionally, integrating Industry 4.0 technologies with circular economy practices can build business models that reuse and recycle materials, thereby contributing to the circular economy (Nascimento et al., 2019).

In conclusion, the circular economy marks a paradigm shift towards sustainable and innovative entrepreneurship, driven by factors such as digital technology, eco-innovation, collaborative efforts, and fostering an entrepreneurial ecosystem. Adopting these factors and opportunities while addressing existing challenges can foster entrepreneurial innovation in the circular economy, paving the way for an economic model that is more sustainable and efficient in resource use.

4. Conclusions

The circular economy offers a promising approach to sustainable development by promoting resource efficiency, environmental protection and economic growth. The integration of digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and Blockchain plays an important role in supporting circular economy principles by increasing transparency, traceability, and operational efficiency. Entrepreneurial innovation in the context of a circular economy involves the creation of new products, services or business models that are aligned with sustainability principles, helping to drive the transition from traditional linear economic models to more regenerative and environmentally friendly economic models. Although there are challenges in implementing a circular economy, the benefits are significant in creating a more sustainable and resilient economic system.

4.1. Implication

This research has important implications for policy makers, business practitioners, and academics. Policymakers can use these findings to design regulations that support the adoption of circular economy practices, facilitate the development of relevant digital technologies, and encourage cross-sector collaboration. For business practitioners, the results of this research highlight the importance of digital innovation and circular business models in achieving long-term sustainability. In addition, this research provides insight for academics to continue studying and developing the concepts of circular economy, digital technology, and entrepreneurial innovation, as well as exploring new ways to integrate sustainability principles into various industrial sectors.

4.2. Limitation

This research has several limitations. First, its focus on the available literature may not cover all aspects and recent developments in the circular economy and digital technologies. Second, this research does not include in-depth empirical analysis to test the proposed hypotheses or models. Third, the existence of differences in economic, social and cultural contexts in various countries may influence the generalization of the findings of this study. These limitations may influence the resulting conclusions and recommendations, so further research is needed to strengthen and expand these findings.

4.3. Future Research

Future research needs to explore more deeply the implementation of circular economy in various industrial sectors with a comprehensive empirical approach. Further studies could also examine the specific role of various digital technologies in promoting circular economy practices, including cost-benefit and environmental impact analysis. Additionally, future research should consider different geographic and cultural contexts to understand how these factors influence the adoption and success of circular economy models. Further research could also focus on developing practical frameworks and tools that can be used by policymakers and business practitioners to overcome challenges and barriers to implementing circular economy principles.

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