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DIGITALIZATION AND ITS ROLE IN THE DEVELOPMENT OF CIRCULAR ECONOMY BUSINESS MODELS

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Abstract. In the pursuit of sustainable development, the circular economy emerges as a crucial paradigm, and this article delves into the interplay between digitization and the evolution of circular business models. The primary objective is to dissect and clarify the fundamental role played by digitalization in propelling the growth and cultivation of circular economy business models. Through a meticulous and comprehensive analysis, we aim to illustrate how digital technologies actively contribute to optimizing processes, fostering innovation, and enhancing the sustainability of circular practices. These digital interventions, we argue, have far-reaching positive impacts on both economic and environmental aspects.

The research methodology employed in this article encompasses a thorough literature review, providing insights into the shared perspectives and discrepancies among various researchers in this domain. Additionally, our approach involves an in-depth analysis of statistical indicators designed to quantify and substantiate the influence of digitization on the development of circular economy business models. By amalgamating theoretical insights with empirical evidence, we seek to provide a robust foundation for understanding the intricate relationship between digitalization and circular economic practices.

The outcomes of our investigation not only contribute valuable insights to the current discourse but also pave the way for future research endeavors. Building on the results of this study, we outline potential avenues for further exploration, addressing aspects that warrant deeper investigation within the context of the overarching theme. This forward-looking perspective aims to inspire and guide future research initiatives, fostering an ongoing dialogue on the dynamic intersection of digitization and the circular economy.

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Introduction

In the contemporary landscape of sustainable development, the imperative to transition from traditional linear, resource-intensive models to more sustainable and regenerative practices is gaining prominence. This shift is encapsulated in the evolving concept of the circular economy, a paradigm that underscores the importance of minimizing waste and environmental impact. At the heart of this transformative journey towards sustainability, digitization emerges as an indispensable catalyst in the development of circular economy business models.

This article seeks to unravel and elucidate the pivotal role played by digitalization in driving the evolution of business models within the circular economy. The overarching objective is to explore and clarify the critical significance of digital technologies in propelling and nurturing this transformative process. Through a meticulous and comprehensive analysis, our aim is to shed light on how digitization acts as a linchpin, optimizing processes, fostering innovation, and sustaining circular practices. The ultimate outcome of these digital interventions, as we argue, manifests in

favorable economic and environmental performance, thereby contributing to the overarching goals of sustainable development.

As we embark on this exploration, we delve into the intricate relationship between digitization and the circular economy, aiming to provide a nuanced understanding of how digital technologies become catalysts for positive change. By synthesizing theoretical insights with empirical evidence, this article endeavors to offer a comprehensive and insightful examination of the multifaceted impact of digitalization on the development of circular economy business models. Through this exploration, we aim not only to contribute valuable insights to the current discourse but also to inspire and guide future research initiatives in the dynamic intersection of digitization and the circular economy.

Literature review

Digitalization and the circular economy represent two burgeoning trends in technology and organizational practices, holding the promise to enhance both company productivity and sustainability outcomes [1]. The integration of digitalization and the circular economy stands as a promising nexus in contemporary technology and organizational landscapes. This convergence holds the potential to not only elevate company productivity but also enhance sustainability outcomes.

The opportunities presented by digital transformation enable companies to identify and adopt novel digital business models. These models can be actualized through technological means and concurrently result in more intelligent production processes. In this context, the human factor is regarded as a pivotal element in the digital transformation, serving as an enabler, implementer, and creative decision-maker [2]. Gaining insight into and analyzing the diverse business models within the circular economy is crucial for identifying successful strategies in sustainable resource management [3]. Recognizing the diversity within circular economy business models becomes imperative, as it provides valuable insights for identifying effective strategies in the realm of sustainable resource management.

On the one hand, there is a requisite for a systematic approach aimed at formulating tangible measures to operationalize a circular business model, facilitating the structured planning of the implementation of a circular economy. Additionally, the resultant circular business model must undergo quantification and evaluation with regard to sustainability dimensions [4]. This approach facilitates structured planning and operationalization of circular economy principles. Moreover, it emphasizes the importance of quantifying and evaluating the resultant circular business model in terms of sustainability dimensions.

The application of circular economy principles is viable in business, yet organizations may find it challenging. Embracing these challenges and leveraging them to reduce expenses through extending the product lifecycle proves advantageous for all stakeholders involved [5]. While the application of circular economy principles is feasible in the business context, organizations may encounter challenges in the process. However, embracing these challenges can prove advantageous, especially when they lead to cost reductions through the extension of product lifecycles—an outcome that benefits all stakeholders involved.

Transitioning from the existing linear economic model to a circular one has garnered heightened interest among major global companies. The motivation behind this shift lies in the substantial financial, social, and environmental advantages it offers. Nevertheless, the global transition from one economic model to another also impacts smaller companies at a micro-level. Therefore, a thorough understanding of the development of circular business models is essential to encourage and support the adoption of circular economy practices [6]. The transition from a linear to a circular economic model has captured the attention of major global companies. The motivation behind this shift is rooted in the significant financial, social, and environmental advantages it offers. Yet, this global transition doesn't only impact large corporations but also affects smaller companies at a micro-level. Therefore, a comprehensive understanding of the development of circular business models becomes essential to encourage and support the widespread adoption of circular economy practices across businesses of varying scales.

The shift towards adopting a circular economy (CE) has emerged as a paramount strategic focus for organizations worldwide. Positioned as an alternative to the traditional linear economy model (take–make–waste), the circular economy operates based on principles of regeneration. It emphasizes the continuous use of materials, waste reduction, and pollution minimization to create a sustainable and environmentally friendly approach.

The integration of digitalization technologies has emerged as a transformative force, empowering the circular economy in multifaceted ways. These technologies collectively contribute to a sustainable and circular approach throughout the entire product lifecycle.

This section specifically delineates the key digitalization technologies and their distinctive impact on driving organizational transformation towards a circular economy (figure 1).

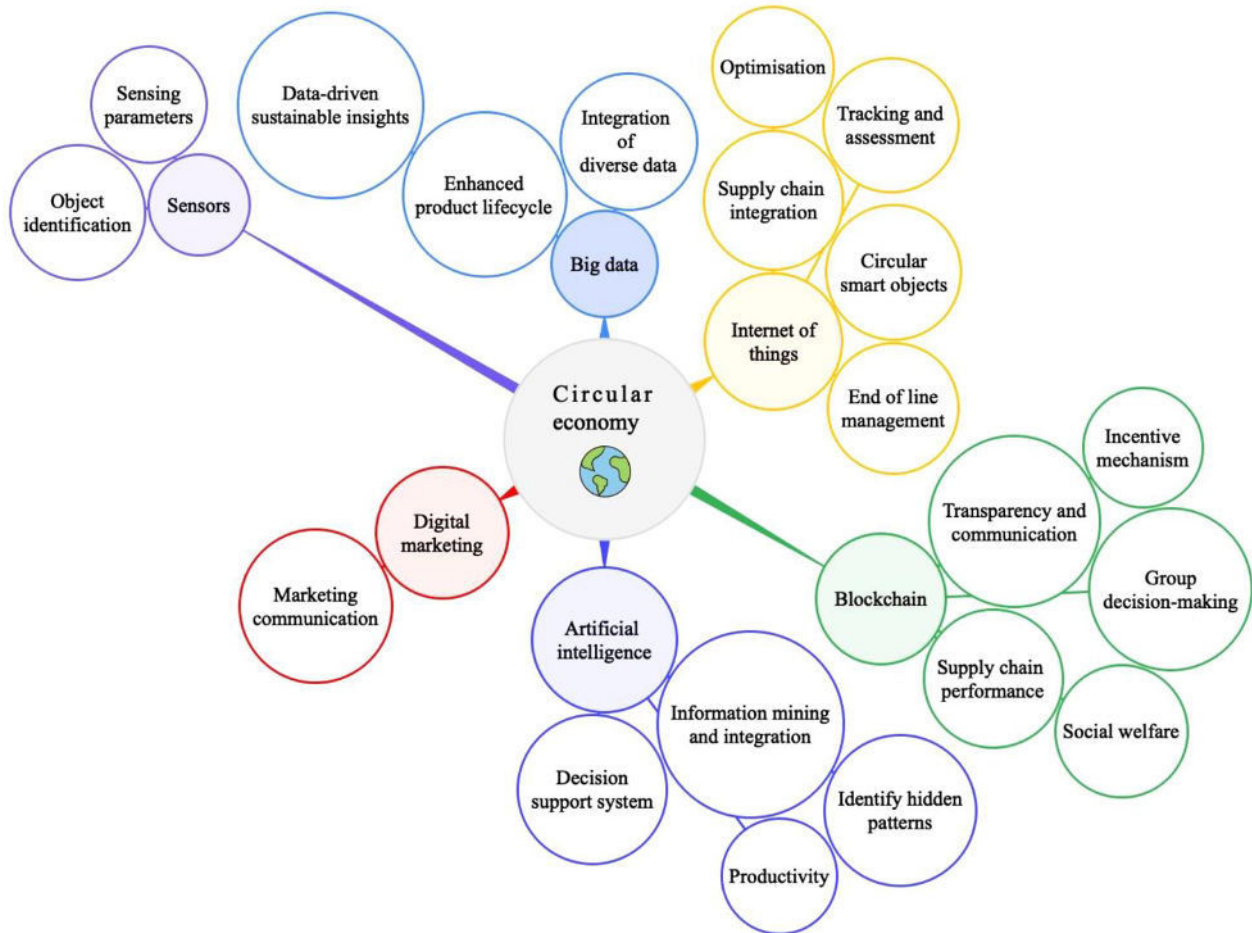


Figure 1. Capabilities driven by digitalization technologies to achieve CE [7]

These digitalization technologies collectively empower the Circular Economy by enhancing data-driven decision-making, improving resource efficiency, ensuring transparency, and fostering a sustainable and circular approach throughout the product lifecycle.

Sensors enable real-time monitoring and data collection throughout the product lifecycle. They facilitate tracking and optimizing resource usage, waste reduction, and enhance the efficiency of circular processes.

Digital Marketing includes the targeted communication, personalized campaigns, and data-driven insights. It supports the promotion of circular products, educates consumers on sustainable choices, and fosters a circular mindset.

Artificial Intelligence is based on the Data analysis, pattern recognition, and decision-making. First of all, optimizes resource management, predicts maintenance needs, and enhances overall efficiency in circular systems.

Blockchain is capable to ensure transparent, secure, and decentralized data storage and transactions, enables traceability of products, ensuring transparency in supply chains, and certifying sustainable practices.

The Internet of Things (IoT) refers to the network of interconnected physical devices, vehicles, appliances, and other objects embedded with sensors, software, and network connectivity, enabling them to collect and exchange data. In simpler terms, IoT involves the connection of everyday objects to the internet, allowing them to send and receive data. IoT facilitates the creation of a smart and connected circular ecosystem, optimizing resource use and enabling efficient recycling processes.

Big Data has capabilities of processing and analyzing large volumes of data. Big Data analytics provides insights into consumption patterns, waste generation, and helps optimize circular strategies for businesses and policymakers.

The innovation of business models for Circular Economy introduces a heightened emphasis on goal orientation compared to the conventional business model innovation perspective. Integrating the value perspective with the incorporation of Circular Economy principles reveals three discernible streams within the literature on circular business models. Each of these streams delineates its unique approach to business model innovation and the role of digital technologies in the context of Circular Economy[8].

Together, these digitalization technologies form a robust foundation for data-driven decision-making, improved resource efficiency, transparency, and sustainability in the circular economy. Their integration not only enhances the efficiency of circular processes but also fosters a global shift towards a more sustainable and circular approach to production and consumption.

The role of digitalization supported by statistical data

Digital tools support the development of innovative circular business models, creating new revenue streams. Companies that embrace digitalization in their circular economy practices can differentiate themselves in the market and gain a competitive edge. the adoption of digital tools in circular economy practices is a strategic investment that not only aligns with sustainability goals but also brings about economic advantages, operational efficiencies, and positive impacts on overall business profitability.

Despite living in the digital era where technologies advance at an extremely rapid pace, leading to the continuous development of digital skills across various fields and areas of responsibility, in recent years, a significant impact in this regard has also been brought about by the COVID-19 pandemic. The following figure illustrates the skills that companies have prioritized addressing through reskilling.

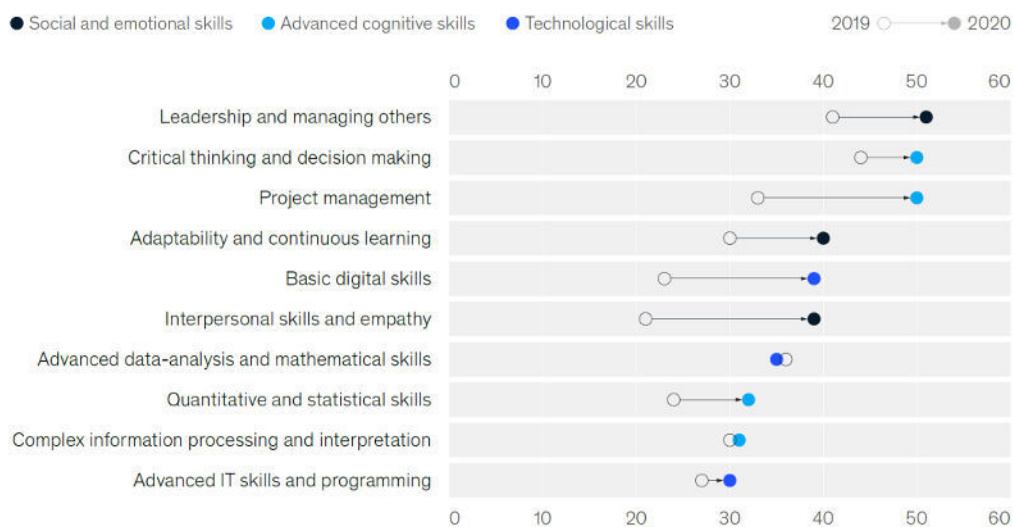


Figure 2. Skills that companies have prioritized to address through reskilling [9]

Predominantly, contemporary corporate emphasis on skill development is centered on refining proficiencies categorized primarily as social, emotional, and advanced cognitive.

The presented data elucidates the proportion of respondents directing their attention towards specific skill development during the years 2019 and 2020. A discernible escalation is observed, specifically from 40% in 2019 to 50% in 2020, signifying an elevated emphasis on the cultivation of leadership and managerial aptitudes. Furthermore, the concentration on critical decision-making skills has marginally increased from 44% to 49%, denoting a sustained acknowledgment of the pivotal role these competencies play within the business milieu. Project management skills have experienced a substantial surge from 33% in 2019 to 49% in 2020, indicating an augmented demand for individuals possessing adeptness in the proficient administration of projects. Similarly, the focus on adaptability and continuous learning has ascended from 29% to 40%, manifesting a cognizance of the dynamic nature inherent in work environments and the imperative for employees to perpetually adapt and acquire knowledge. Basic digital skills have undergone a marked increase from 22% in 2019 to 39% in 2020, underscoring the escalating significance of digital literacy within the contemporary workforce. Notably, there is a conspicuous intensification in the emphasis on interpersonal skills and empathy, ascending from 20% to 39%, signifying an acknowledgment of the paramount importance of these soft skills in professional settings.

In the contemporary digital era, the profound impact of digital transformation, coupled with the rapid and extensive changes brought about by emerging technologies, has revolutionized work environments. This transformation is marked by a decreased demand for employees engaged in routine manual tasks and an increased necessity for digitally skilled workers. This shift underscores the significance of fostering both digital and soft skills among employees, as organizations strive for business growth [10].

The percentage for advanced data-analysis and mathematical skills remains constant at 36% across both years, indicating a sustained commitment to the development of these intricate proficiencies. Moreover, a modest increase from 24% to 34% is observed, symbolizing a growing recognition of the significance of individuals capable of effectively processing and interpreting complex information. Despite a slight decrease from 27% to 30%, the concentration on advanced IT skills and programming persists substantially, underscoring the enduring relevance of these technical competencies. The data attests to a discernible shift in focus towards skills characterized by social, emotional, and cognitive advancement. The notable amplifications in project management, basic digital skills, and interpersonal skills suggest a responsiveness to the evolving requisites of the contemporary workplace, concurrently underscoring the perpetual recognition of the paramountcy of technological proficiency and adaptability.

European countries have demonstrated a heightened focus on sustainability, digitalization, artificial intelligence (AI), and digital transformation compared to other regions worldwide. This emphasis can be attributed, in part, to the comprehensive legislation within Europe, accompanied by potential punitive measures and sanctions targeting businesses. These measures are designed to address concerns related to the digitalization of processes, which, if not approached responsibly, can adversely affect citizens and the environment. Issues include job losses, insufficient job enrichment, the automation of recruitment, retention, and performance metrics, as well as a potential decline in interpersonal interactions [11].

The next figure (figure 3) reflect the share of respondents who report or expect ‘modest’ or ‘significant’ value created from sustainability programs, by industry based on the McKinsey Global Surveys results [9]. The aim of this survey is to assess and understand the practices, strategies, and motivations related to sustainability among companies, with a particular focus on those identified as "value creators.". The survey results highlight important insights that can be linked to circular economy business models, emphasizing the significance of sustainability practices and strategic approaches.

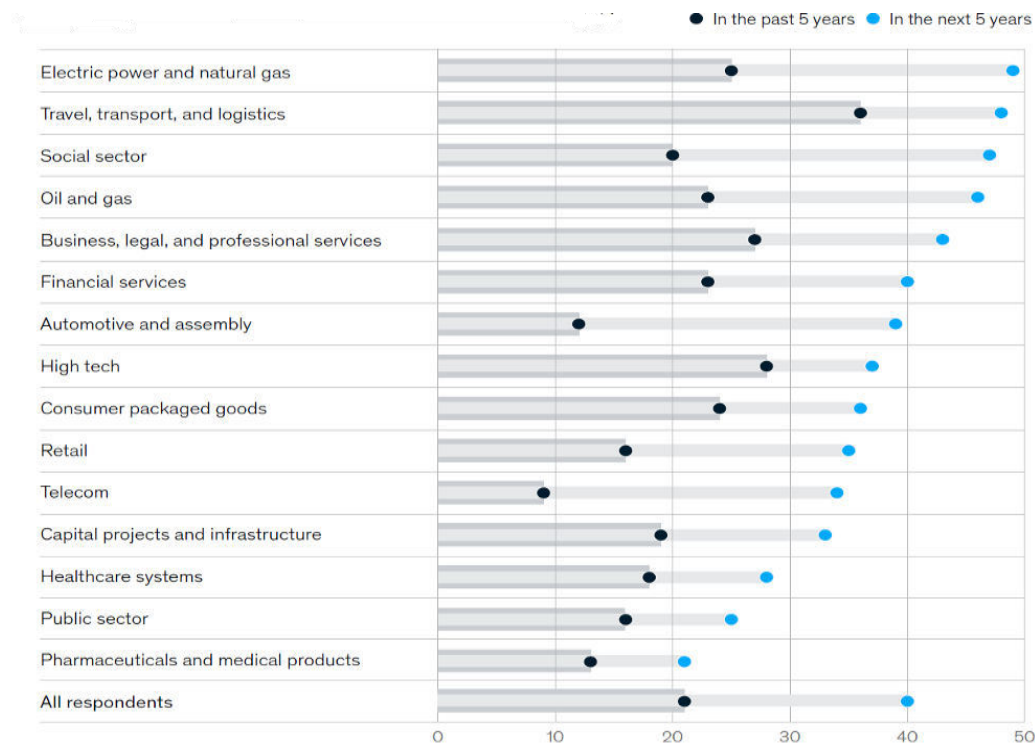


Figure 3. Share of respondents who report or expect ‘modest’ or ‘significant’ value created from sustainability programs, by industry [9]

Organizations identified as value creators are more likely to engage in sustainability to fulfill their organizational purpose, align with goals, mission, or values, and make a tangible, positive impact. Digitization plays a crucial role in aligning sustainability efforts with organizational values. Technologies such as data analytics, IoT, and AI enable organizations to measure and optimize their impact, ensuring alignment with mission and values. In the context of the circular economy, digitization facilitates the tracking and optimization of resource usage, waste reduction, and overall sustainability. Respondents at other companies are more likely to engage in sustainability to meet industry norms, standards, or regulatory requirements. While regulatory compliance is a common motivator, digitization enables companies to go beyond mere compliance. Technologies like blockchain provide transparent and traceable supply chains, ensuring adherence to standards. In the circular economy, digitization helps optimize processes to meet and exceed regulatory requirements while fostering sustainable practices.

Circular modes of production, commonly referred to as the circular economy, find favor in both political and business spheres as a solution to address the limitations of traditional linear operating models. Despite the growing recognition, academic literature on the circular economy is still in its early stages, and there is a noticeable lack of emphasis on the implications for supply chain management [12]. This is noteworthy given the crucial role of supply chain innovation in transitioning toward a more resource-efficient and circular economic framework.

Forty percent of respondents expect sustainability programs to generate value in the next five years, nearly double the current share. Digitization is central to unlocking value from sustainability initiatives. Technologies such as big data analytics, AI, and IoT provide insights into consumption patterns, waste generation, and circular strategies' optimization. In the circular economy, digitization enhances resource efficiency and transparency, contributing to the anticipated increase in value creation. The survey results underscore the importance of organizational motives, with digitization serving as an enabler for sustainability initiatives. The alignment of goals, values, and mission is facilitated by digital technologies, contributing to value creation. In the context of the circular economy, digitization emerges as a key driver for optimizing resource use, reducing waste, and fostering sustainable practices across various industries.

Industries show varying expectations for value creation from sustainability programs. In sectors like electric power, natural gas, and travel, digitization is crucial for optimizing resource usage, reducing waste, and aligning with circular principles. For example, IoT sensors in the energy sector enable real-time monitoring, while data analytics in travel and logistics enhance efficiency. Expectations align with the potential of digitization to drive circular practices and create value across diverse industries.

Conclusions and suggestions

In conclusion, this article extensively explores the intersection of digitization and circular economy business models, elucidating the critical role played by digital technologies in advancing sustainability practices. The meticulous analysis demonstrates that the integration of digitalization technologies empowers the circular economy, fostering innovation, optimizing resource efficiency, and ensuring transparency throughout the product lifecycle. The outcomes of digital interventions positively impact both economic and environmental aspects, aligning with the overarching goals of sustainable development.

Future research could delve deeper into industry-specific dynamics to better understand how digitalization contributes to circular practices in diverse sectors. This could provide tailored insights for each industry, facilitating more targeted and effective implementation. Also, future research could include an in-depth exploration of stakeholder perspectives, such as consumer attitudes, regulatory considerations, and the role of government policies in shaping the digitization-circular economy nexus. This holistic approach would enhance the overall understanding of the ecosystem. Investigating how different digital technologies synergize within circular business models could be an avenue for future research.

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