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The role of industry 4.0 technologies in implementing circular business models

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Introdução

Industry 4.0 technologies transform the processes of value creation, capture, and delivery for companies transitioning to circular business models (Chauhan et al., 2022). These technologies facilitate the circularization of business models by continuously collecting and analyzing data, thereby supporting strategic decisions (Rosa et al., 2020). I4.0 technologies are acknowledged in scientific literature as enablers of circular practices within organizations; however, it remains unclear how these technologies are implemented in circular business models (Rosa et al., 2020).

Problema de Pesquisa e Objetivo

Circular business models (CBMs) are essential for the transition to a circular economy, as they employ four key strategies to mitigate socio-environmental impacts: reducing, slowing down, closing, and regenerating material cycles (Bocken et al., 2022). Smart technologies can facilitate the adoption of circularization strategies and promote changes in companies' value chain, providing efficient transition to CBMs (Belhadi et al., 2022). Therefore, this work addresses the following research question: How can Industry 4.0 technologies facilitate the implementation of circular business models?

Fundamentação Teórica

Circular business models (CBMs) are essential for the transition to a circular economy, as they employ four key strategies to mitigate socio-environmental impacts: reducing, slowing down, closing, and regenerating material cycles (Bocken et al., 2022). Smart technologies can facilitate the adoption of circularization strategies and promote changes in companies' value chain, providing efficient transition to CBMs (Belhadi et al., 2022). Therefore, this work addresses the following research question: How can Industry 4.0 technologies facilitate the implementation of circular business models?

Metodologia

The article conducts a systematic literature review and analyzes illustrative CBM cases at the micro level. The review, performed in January 2024 using Scopus, analyzed 20 articles to create a framework detailing key Industry 4.0 technologies and their functionalities in circular business models. This framework was tested on companies listed in the Circular X database, resulting in 66 categorized circular business models.

Análise dos Resultados

Five key technologies—Artificial Intelligence (AI), Big Data, Blockchain, Cloud Computing, and the Internet of Things (IoT)—are fundamental in enabling circular strategies within organizations. These technologies are crucial for data collection, integration, and analysis, each offering specific functionalities. Big Data provides essential infrastructure for data virtualization, supporting all data management stages. AI, Big Data, and IoT are vital in operational circular business models, aiding in value creation and delivery, thus supporting the development of circular business models.

Conclusão

Key technologies—AI, Big Data, Blockchain, Cloud Computing, and IoT—are crucial for data collection, integration, and analysis. These technologies transform data into actionable insights, aiding decision-makers. The study presents a framework outlining these technologies' roles and investigates real-world cases, offering practical insights and challenges. However, limited

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integration of Industry 4.0 technologies in CBMs and low circularization levels in operational models were noted. Further research on circular startups and case studies from the Global South is needed.

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