

DIGITALIZATION AS A DRIVER OF CIRCULAR ECONOMY TRANSITION: A CONCEPTUAL FRAMEWORK FOR EMERGING ECONOMIES

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ABSTRACT

The transition from a linear to a circular economy (CE) presents significant managerial challenges, particularly for small and medium-sized enterprises (SMEs) in emerging economies. While digitalization is widely recognized as a key enabler of CE practices, its role in supporting business model transformation remains underexplored in developing country contexts. This paper proposes a conceptual framework for integrating digital tools into the implementation of the circular economy, drawing on the case of Serbia. Applying a Quadruple Helix model — encompassing academia, government, industry, and civil society — the paper identifies the main barriers to CE adoption, including limited managerial awareness, weak regulatory incentives, and insufficient digital infrastructure. As a practical solution, the paper proposes a digital waste exchange platform enabling SMEs to advertise surplus materials as inputs for other enterprises, thereby extending product lifecycles and reducing waste. The proposed framework offers actionable guidance for managers and policymakers navigating the dual challenges of the digital and green transitions, and lays the groundwork for future empirical research in this domain.

Key words: Circular economy, Digitalization, SMEs, Sustainable business models, Emerging economies

INTRODUCTION

The transition from a linear to a circular economy (CE) has become a central topic in modern sustainability research. The traditional model “take–make–dispose” is shown to be increasingly unsustainable, due to resource depletion and rising waste generation (Busu, 2019; Kirchherr, Reike & Hekkert, 2017). Recent projections suggest that global resource demand could significantly increase by 2050, further intensifying environmental pressures (Fan & Fang, 2020).

The CE promotes resource efficiency, waste minimization and reuse of materials, contributing to environmental, economic and business benefits (Diemer & Dierickx, 2020; Gravagnuolo, Angrisano & Fusco Girard, 2019). On the other hand, digitalization has emerged as a key enabler of CE practices, allowing organizations to monitor resource flows, optimize processes and enhance transparency (Parida, Sjödin & Reim, 2019; Antikainen, Uusitalo & Kivikytö-Reponen, 2018). This is particularly important for emerging economies, where structural limitations may slow down the transition.

DIGITALIZATION AND CIRCULAR ECONOMY IN EMERGING ECONOMIES

Digital technologies play a critical role in enabling CE practices by improving data availability, traceability and decision-making (Kintscher, Lawrenz, Poschmann, & Sharma, 2020). Through digital tools, companies can track materials, identify inefficiencies and facilitate reuse and recycling processes.

Hence, research shows that digitalization supports new business models aligned with CE principles, such as product-service systems and resource-sharing platforms (Bressanelli, Adrodegari, Perona & Saccani, 2018; Okorie, Salonitis, Charnley, Moreno, Turner & Tiwari, 2018). Additionally, industry 4.0 technologies contribute to the development of more efficient and sustainable production systems (Dantas, De-Souza, Destro, Hammes, Rodriguez & Soares, 2020; De Sousa Jabbour, Jabbour, GodinhoFilho & Roubaud, 2018).

However, in emerging economies, the implementation of digital solutions is often constrained by lower levels of technological development and limited access to infrastructure (Ranta, Aarikka-Stenroos & Väisänen, 2021).

BARRIERS TO CIRCULAR ECONOMY TRANSITION IN EMERGING ECONOMIES

The transition to a CE in emerging economies is hindered by several structural and institutional barriers. One of the main challenges is the limited awareness of CE principles among businesses, which often fail to recognize the potential value of waste as a resource (Popović, Ivanović-Đukić & Miljić, 2022). Regulatory and institutional shortcomings also present significant obstacles, thus, the lack of coherent policies and incentives reduces the motivation for companies to invest in CE solutions (Busu, 2019).

Additionally, insufficient infrastructure and a lack of skilled workforce limit the adoption of digital technologies which are necessary for CE implementation (Chateau, Bibas & Lanzi, 2018). Another important issue is the unclear value proposition of data integration systems, which makes it difficult for organizations to fully leverage digital tools in CE practices (Kintscher et al., 2020).

CONCEPTUAL FRAMEWORK FOR DIGITAL-DRIVEN CIRCULAR ECONOMY TRANSITION

To overcome these, above-mentioned challenges, this manuscript proposes a conceptual framework based on the integration of digital technologies and CE principles.

The framework is grounded in the Quadruple Helix model, which emphasizes collaboration between academia, industry, government, and civil society (Fogarassy & Finger, 2020). Hence, at its core is a digital platform that enables SMEs to exchange waste materials, transforming them into valuable inputs for other companies. Thus, this approach supports resource efficiency, reduces waste and promotes collaboration across sectors.

Digital platforms enhance transparency, improve data sharing, and facilitate the development of circular business models (Antikainen et al., 2018; Ranta et al., 2021). From a managerial perspective, the mentioned framework enables organizations to optimize resource use and reduce operational costs. From a policy perspective, it highlights the importance of digital infrastructure and supportive regulatory environments.

DIGITAL PLATFORMS AND BUSINESS MODEL INNOVATION IN CIRCULAR ECONOMY

The transition toward a CE is not solely a technological shift, but also a transformation of traditional business models. In this context, digital platforms play a crucial role by enabling new forms of value creation, exchange and collaboration among stakeholders.

Unlike conventional linear models, circular business models require continuous interaction between producers, consumers and other actors involved in the product lifecycle. Digital platforms facilitate this interaction by serving as intermediaries that connect supply and demand for secondary resources.

In doing so, they contribute to the creation of, so-called, closed-loop systems in which materials are reused and redistributed rather than discarded.

One of the key contributions of digital platforms is their ability to support the emergence of platform-based ecosystems. These ecosystems enable multiple actors to participate simultaneously, creating network effects that enhance efficiency and scalability. For example, companies can use digital platforms to share information about available waste streams, identify potential partners and coordinate logistics related to material exchange. This will reduce transaction costs and increases the feasibility of circular practices (Van Capelleveen, Amrit, Zijm, Yazan & Abdi, 2021). Furthermore, digital platforms enable the integration of data-driven decision-making into circular business models. By collecting and analyzing data on material flows, organizations can identify inefficiencies, predict demand for secondary resources and optimize resource allocation. This aligns with the broader trend of digital transformation, where data becomes a key strategic asset in achieving sustainability goals (Okorie et al., 2018).

Another important aspect is the role of digital platforms in supporting innovation, as well as, by providing access to shared resources and knowledge, platforms foster experimentation and the development of new circular solutions. Thus, this is particularly relevant for SMEs, which often lack the internal capacity to invest in innovation independently. Through participation in digital ecosystems, SMEs can leverage external knowledge and collaborate with other stakeholders, including research institutions and technology providers. In addition, digital platforms contribute to transparency and trust among stakeholders. In CE systems, where materials may “change hands” multiple times, the availability of reliable information is essential. Digital tools enable traceability of materials, ensuring that quality standards are met and reducing uncertainty in transactions. This, in turn, encourages broader participation in circular practices (Turner, Moreno, Mondini, Salonitis, Charnley, Tiwari & Hutabarat, 2019).

However, the successful implementation of platform-based solutions depends on several factors, such as user adoption, data standardization and interoperability between systems. Without a critical mass of users, platforms may fail to generate sufficient value. Therefore, strategies for user engagement and incentives for participation are essential components of digital platform development in the CE context.

Overall, digital platforms represent a key mechanism for enabling business model innovation in the CE. By facilitating collaboration, improving information flow and supporting data-driven decision-making, they provide a foundation for more sustainable and resilient economic systems.

METHODOLOGY

Research problem and subject of the study

The transition from a linear “take-make-dispose” economic model to a CE model represents a critical sustainability goal, especially because its execution faces significant friction in developing contexts. While digitalization is theoretically recognized as a powerful catalyst for circular practices, there is a distinct lack of actionable mechanisms tailored for SMEs, operating within institutional and infrastructural constraints. Consequently, the main subject of this study is the crossroad of digital tool deployment and circular business model transformation within an emerging economy framework, focusing specifically on the Republic of Serbia.

Research questions and objectives

The main goal of this paper is to construct a comprehensive conceptual framework that identifies how digital technologies can practically drive the CE transition under the specific socio-economic conditions of an emerging market. To achieve this, the study addresses the following research questions:

- RQ1: What are the primary structural, institutional and technological barriers that disrupt SMEs in emerging economies from adopting circular economy principles?
- RQ2: How can a digital platform be structurally aligned with the Quadruple Helix model to facilitate waste-to-resource exchanges among distributed market participants?
- RQ3: In which ways does data-driven decision-making via digital intermediaries raise business model innovation and economic resilience for small-sized enterprises?

Methodological approach

This study employs a qualitative and conceptual research design based on modern literature synthesis and framework development. The methodological flow is implemented in three distinct phases:

- I. *Information synthesis and barrier identification* – systematic review of contemporary literature (traverse CE definitions, industry 4.0 applications and institutional economics) was conducted to map out the basic friction points in developing nations;
- II. *Structural modeling (Quadruple Helix)* – using the Quadruple Helix framework as a basic lens, it's mapped out the required multi-stakeholder ecosystem. Thus, this involved analyzing the interdependent roles of academia, government, industry and civil society in overcoming the identified adoption barriers;
- III. *Conceptual artifact design* – deductive reasoning was employed to design a functional solution, a digital waste exchange platform framework. This platform serves as a conceptual bridge, transforming theoretical multi-sector collaboration into a practical tool for secondary resource optimization and transaction cost reduction.

CONCLUSION

This paper examines the role of digitalization as a driver of CE transition, with a special focus on emerging economies. The analysis has revealed that, while the CE offers significant environmental and economic benefits, its implementation is often hindered by structural, institutional and technological barriers.

Digitalization emerges as a critical enabler in addressing these challenges. Hence, through the use of digital platforms, organizations can improve resource efficiency, enhance collaboration and develop innovative business models that support circular practices. In particular, the proposed framework highlights the importance of integrating digital tools with stakeholder collaboration, as emphasized by the Quadruple Helix model.

The case of emerging economies, such as Republic of Serbia, illustrates both the opportunities and constraints associated with this transition. Limited awareness, insufficient infrastructure and regulatory gaps remain significant obstacles. But, however, the development of digital platforms for resource exchange presents a practical and scalable solution, especially for SMEs. From a managerial perspective, adopting digital circular solutions can lead to cost reduction, improved efficiency and increased competitiveness. Thus, from a policy perspective, creating a supportive environment through investments in digital infrastructure, regulatory alignment and capacity building is essential. The integration of digitalization and CE principles contributes to organizational resilience by reducing dependence on finite resources and enabling more flexible and adaptive business operations.

Future research should focus on empirical validation of the proposed framework and further exploration of digital platform impacts across different sectors and economic contexts.

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