

# Chapter 12

## Transforming Supply Chains Through the Implementation of the Circular Economy and Sustainable Closed–Loop Models

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### ABSTRACT

*The study analyzes how the convergence between circular economy and closed-loop models reconfigures supply chains still anchored in linear patterns. Based on literature review, cross-industry case studies, and examination of emerging policies, technological, financial, and cultural barriers that keep global circularity below ten percent are documented, as well as incentives that favor rapid extraction over resource regeneration. The findings show that the combined adoption of digital twins, smart contracts, and multi-capital metrics increases visibility into material flows, facilitates coordination between actors, and reduces logistics costs by up to 23%, while decreasing the carbon footprint and strengthening resilience to disruptions. It is concluded that effective circularity demands collaborative governance frameworks, green investment and dynamic capacity building that allow organizations to perceive changes, mobilize knowledge and reconfigure assets with agility, turning the regeneration of resources into a central vector of competitiveness and social legitimacy.*

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## INTRODUCTION

The ability to sustain human progress without devouring the biophysical foundations of the planet has gone from being an ethical aspiration to constituting a strategic imperative. Under this premise, the circular economy is emerging as a transformative narrative that reconfigures competitiveness by placing the regeneration of resources at the center of business value; However, the global circularity rate remains anchored in single-digit values, evidence of the technical, financial and cultural inertias that continue to relegate the closing of loops to a marginal participation of industrial activity. Pan-European studies show that the lack of incentives for material recovery, coupled with accounting indicators that privilege immediate productivity, limits the flow of capital towards infrastructure reuse and refurbishment, perpetuating the dissonance between discourse and practice (Miatto et al., 2025; Corvellec et al., 2022; Zink & Geyer, 2017).

The latest research agrees that the circular transition cannot be restricted to the end of the useful life of products or focus exclusively on waste management; but which requires redesigning the offer from its conception and reconfiguring supply chains through reduction, reuse and revaluation loops. From the theory of resources and dynamic capabilities, it has been shown that perceiving changes, absorbing knowledge and reconfiguring assets constitutes an indispensable strategic tripod to abandon the extract-produce-discard paradigm and embrace closed-loop configurations. This tripod is legitimized when it is articulated with integrative visions of sustainability that transcend the dichotomy of economy versus ecology and propose robust metrics to capture value throughout the life cycle (De Angelis et al., 2023).

Digitization increases the viability of such proposals by providing granular visibility into the functional degradation of assets and the provenance of materials. The emergence of digital twins, supported by prescriptive analytics and edge computing, synchronizes physical flows with contextual data in near-zero latency and anticipates optimal return windows that reduce logistical inefficiencies and free up capital trapped in recovery inventories. Portfolios of asset research models in the aeronautics, electronics, and textile sectors show decreases in lifecycle costs when twins incorporate predictive maintenance algorithms and integrated carbon certification (Mügge et al., 2024).

However, financial viability will depend on measurement frameworks that combine economic, environmental and social indicators. The proliferation of heterogeneous metrics has diluted the credibility of sustainability reporting and makes it difficult to compare across industries; Thus, a research agenda is invoked that prioritizes hybrid boards capable of simultaneously weighing retained economic value, carbon intensity, effective duration of service, and distributive justice. Causal models based on system dynamics show that the integration of these variables reduces efficiency

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