


Chapter 4

Smart Technologies for Sustainable Logistics: AI, Blockchain, and Robotics in the Carbon-Free Era

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ABSTRACT

In recent years, the transition towards circular supply chains has gained significant momentum as organizations strive to enhance sustainability and reduce waste. The adoption of digital tools and technologies plays a pivotal role in enabling effective traceability within these circular systems. This article explores the innovative tools and technologies that facilitate enhanced traceability in circular supply chains, highlighting their importance in ensuring transparency, accountability, and sustainability. The study delves into various digital solutions, such as blockchain, IoT, and big data analytics, that provide real-time insights into product lifecycles, thereby allowing organizations to monitor and manage resources efficiently. By examining case studies and best practices, this article aims to provide a comprehensive understanding of how digital technologies can transform circular supply chains and contribute to a more sustainable future. Ultimately, this research serves as a foundation for both academia and industry.

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1. INTRODUCTION

As the global economy increasingly grapples with the consequences of resource depletion and environmental degradation, the concept of circular supply chains has emerged as a viable alternative to traditional linear models. Circular supply chains focus on minimizing waste and maximizing the value of resources through practices such as recycling, remanufacturing, and reuse. In this context, traceability becomes a critical component, enabling organizations to track the lifecycle of products, monitor resource flows, and ensure compliance with environmental regulations. However, achieving effective traceability in circular supply chains can be challenging, particularly given the complexity and interconnectivity of modern supply networks (P.F. Campos, et.al, 2019).

The advent of digital technologies presents an opportunity to overcome these challenges and enhance traceability within circular supply chains. Innovations such as blockchain, the Internet of Things (IoT), and big data analytics have the potential to revolutionize the way organizations monitor and manage their resources. Blockchain technology, for instance, offers a decentralized and immutable ledger that allows for secure tracking of products throughout their lifecycle, ensuring transparency and accountability. Similarly, IoT devices can provide real-time data on product conditions, enabling organizations to respond quickly to changes in supply chain dynamics (E. Tijan, S. et.al, 2019). This article aims to explore the role of digital tools and technologies in enhancing traceability within circular supply chains. By examining various digital solutions, their applications, and case studies of organizations successfully implementing these technologies, this study will provide valuable insights into the potential benefits and challenges of integrating digital solutions into circular supply chain management. Furthermore, the article will address the implications of these findings for both academia and industry, highlighting areas for future research and potential directions for practice.

The increasing emphasis on sustainability, coupled with evolving consumer expectations, has necessitated a shift towards more transparent and responsible supply chains. As businesses strive to meet these demands, understanding how digital technologies can facilitate enhanced traceability in circular supply chains becomes paramount (G. Mirabelli & V. Solina, 2020). This research seeks to contribute to the growing body of knowledge on this topic by providing a comprehensive overview of the tools and technologies available, their impact on supply chain management, and the potential for driving sustainable practices across industries.

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