Chapter 6
Harnessing Big Data for Reverse Logistics and Waste Management:
Pathways to Sustainable Supply Chains

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ABSTRACT

This chapter investigates the transformative potential of Big Data Analytics (BDA) in promoting sustainable practices within reverse logistics and waste management, highlighting its contribution to the development of circular supply chains. It delves into the basic concepts of reverse logistics, explores perspectives that guide sustainable operations, and examines the capabilities of BDA in predictive analytics, AI-supported decision-making, and real-time monitoring. Practical implementations, including product returns management, recycling process optimization, and integration of waste management in urban and industrial contexts, are discussed, along with challenges such as data privacy, interoperability, and organizational

DOI: 10.4018/979-8-3373-6896-2.ch006

preparedness. Additionally, the chapter illustrates how BDA aligns with circular economy principles, supporting product life extension, secondary market development, and material recirculation, while future directions point to blockchain traceability, ethical AI, and alignment with ESG and SDG frameworks.

INTRODUCTION

In the last ten years, the discussion of sustainability in the world has already changed the approach to the design and management of supply chains to a great extent. The increasing environmental demands, the straitening rules, and the increasing need of society to obtain ethical production have compelled organizations to revise their priorities in terms of operations. Subsequently, the need to incorporate the principles of sustainability into-the logistics and supply chain operations has turned into not an option but rather a necessity. In this shift, two areas have become especially important; these are reversing logistics and waste management. Not only do these processes allow marshaling one-time recovery and reuse of materials, but they are the basis of a circular economy (CE), where the waste to its lowest limits, and the resources are introduced into the production cycle once again. Interestingly, the increasing faculties of Big Data Analytics (BDA) are currently altering the way organizations plan, monitor and optimize these reverse logistics systems to slowly shift to more agile and regenerative supply chain ecosystems (Bag et al., 2021). Reverse logistics is a broad process that includes the recovery of products, repair of defective products, re-manufacturing of parts, recycling of products, and end-of-life products. All these activities were long thought of as a drain on the supply chain or as a simple cost-generating addition to the supply chain. Nevertheless, they are viewed as strategic resource points of competitive advantage development now with the current focus on sustainability and value recovery. On the same note, waste management has moved past the normal compliance processes and has developed into a major aspect of corporate sustainability plans. However, these two fields produce vast volumes of information that-is usually cumbersome, disjointed, and unstructured that originates in a wide variety of sources including smart sensors, databases of customers, and inventory. The data cannot be easily utilized and interpreted, and that is where the BDA is placed. It provides processing, relating and interpreting of these vast streams of information using the power of analytics and intelligent forms (Hasan et al., 2025; Xu et al., 2021).

The BDA is an integration of computational capability, better algorithms as well as data-based arguments to reach more informed and quicker choices in the organizations. The data obtained by the IoT gadgets, RFID tags, enterprise applications, and other feedback interfaces of the customers can be aggregated and processed to