

Improving Waste Management Operations in the Oil and Gas Industry through Reverse Logistics

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Abstract

This doctoral dissertation investigates the role of reverse logistics in improving waste management operations within the oil and gas industry, with a particular focus on enhancing operational efficiency, regulatory compliance, and environmental sustainability. The study was motivated by the growing complexity and volume of waste generated by oil and gas activities and by the increasing pressure on companies to manage these waste streams responsibly while maintaining cost efficiency and operational continuity. Despite the strategic relevance of reverse logistics, its implementation in the oil and gas sector remains fragmented and underexplored, especially when compared to manufacturing, retail and consumer goods industries.

Reverse logistics is examined as a strategic component of supply chain management rather than a supporting operational function. In the context of the oil and gas industry, reverse logistics encompasses the planning, implementation, and control of backward flows of waste, materials, and related information from points of generation to appropriate treatment, recovery, or disposal facilities. The study highlights that ineffective waste management and poorly structured reverse logistics systems can result in environmental risks, legal penalties, increased costs, and reputational damage. At the same time, well-designed reverse logistics systems offer opportunities for waste reduction, material recovery, process optimization, and improved sustainability performance.

The primary objective of this research was to explore how reverse logistics can be strategically integrated into waste management operations in the oil and gas industry and to identify the drivers, barriers, organizational structures, outsourcing practices, and technological enablers that influence its effectiveness. To achieve this objective, the study adopted a qualitative multi-method research approach combining a systematic literature review, semi-structured interviews, and multiple case studies. This approach enabled an in-depth exploration of both theoretical perspectives and real-world industry practices.

The research began with a systematic literature review that analyzed existing academic studies on reverse logistics and waste management in the oil and gas sector. The review revealed significant theoretical, empirical, and methodological gaps, including limited sector-specific frameworks, insufficient empirical evidence, and a lack of studies addressing reverse logistics network design, stakeholder coordination, outsourcing decisions, and the application of Industry 4.0 technologies. These gaps formed the basis for the formulation of research problems and six research questions guiding the empirical investigation.

The empirical component of the study is based on semi-structured interviews with managers and specialists from six oil and gas companies and one waste management solutions provider. These interviews were complemented by multiple case studies, allowing for a comparative analysis across organizations operating in both developed and developing country contexts. Data analysis was conducted using grounded-theory-inspired

coding techniques, including open, axial, and selective coding, which facilitated the systematic identification of patterns, relationships, and core themes emerging from the data.

The findings demonstrate that reverse logistics plays a critical role in structuring waste management operations in the oil and gas industry. Key drivers of reverse logistics implementation include regulatory requirements, cost considerations, corporate sustainability objectives, and stakeholder pressure. However, the study also identified significant barriers, such as fragmented organizational responsibilities, limited infrastructure, insufficient contractor integration, data availability challenges, and uneven adoption of digital technologies. Outsourcing emerges as a dominant practice in waste-related reverse logistics, yet the lack of structured decision-making frameworks and performance monitoring mechanisms often limits its effectiveness.

The research further highlights the growing importance of technology and digital tools in advancing reverse logistics and waste management. Industry 4.0 technologies, including digital waste tracking systems, data analytics platforms, and integrated information systems, are shown to enhance transparency, coordination, and performance monitoring. Nevertheless, their implementation remains inconsistent across companies and regions.

Based on empirical and theoretical findings, the dissertation proposes a set of practical recommendations for designing and improving reverse logistics networks in oil and gas companies. These recommendations emphasize waste stream mapping, consolidation point design, transportation optimization, technology integration, stakeholder collaboration, and scalability. By linking empirical insights with theoretical concepts, the study provides a structured and applied framework that supports more effective reverse logistics implementation.

In conclusion, this doctoral dissertation contributes to the literature by extending reverse logistics theory to the oil and gas sector and by providing empirical evidence from multiple organizational contexts. It offers both academic and practical value by addressing identified research gaps and by presenting actionable guidance for industry practitioners seeking to improve waste management performance through reverse logistics. The study positions reverse logistics as a central mechanism for achieving sustainable and efficient supply chain management in the oil and gas industry.

Keywords: reverse logistics; waste management; oil and gas industry; supply chain management; sustainability