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DESIGNING A SUSTAINABLE CLOSED-LOOP SUPPLY CHAIN FOR AUTOMOTIVE PART LOGISTICS: TOWARDS CIRCULAR ECONOMY

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Abstract

Despite the increasing complexity of automotive supply chains, limited studies have addressed the simultaneous integration of cross-docking and transshipment within a sustainable closed-loop supply chain (CLSC) under uncertainty. To fill this gap, this study develops a robust multi-objective optimization model that considers economic, environmental, and social goals while managing the return and recovery of defective parts. The proposed model is solved using the ε-constraint method and tested on a real case from Iran's automotive industry. Numerical results demonstrate that the implementation of resilience strategies, particularly backup suppliers, leads to a 40% improvement in resource reuse and a significant profit increase under disruption scenarios. In the third scenario, supporting suppliers contribute up to 61% of material supply, indicating strong adaptability. Sensitivity analyses reveal that higher product return rates decrease profit and increase CO_2 emissions, and that extended processing times in cross-docks reduce overall network efficiency. The findings highlight the model's capability to optimize facility locations, flow allocation, and recovery operations in a disrupted environment. Overall, the model offers valuable insights for decision-makers aiming to design resilient and sustainable automotive supply chains that balance operational profitability with environmental and social responsibilities.

Key words: automotive parts supply chain, circular economy, cross-docking, multi-objective optimization, resilience, sustainability, transshipment

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