

MULTI-OBJECTIVE OPTIMIZATION IN THE MANAGEMENT OF WASTE-DERIVED FUEL SUPPLY CHAINS: A COMPREHENSIVE APPROACH FOR COLOMBIA

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Abstract

The increase in greenhouse gases and the need for renewable energy alternatives position Refuse-DerivedFuel RDF as an attractive alternative, particularly for the cement industry as a partial substitute for coal. However, its implementation depends on supply chains, the availability of materials for its production, and the consideration of economic, environmental, and social impacts. Therefore, this study addresses the multi-objective optimization of a two-layer logistics network that maximizes material flows and job creation, and minimizes operating costs and CO₂ emissions for the distribution of municipal solid waste (MSW) destined for the production of refuse-derived fuel (RDF) in Colombia. The problem was solved using the ϵ -constraint method, and a comparison with the results of mono-objective optimization was carried out. Additionally, a sensitivity analysis was performed to reveal the influences of RDF composition and the percentage of captured demand. The results reveal efficient solutions that allow mobilizing between 88,822 and 4,280,525 kg of daily inputs, with operating costs from 18,786 to 926,519 USD/day, generating between 209,782 and 10,233,821 kg CO₂/day, and impacting between 50 and 2,633 full-time jobs. A linear relationship between costs and emissions was identified, while the sensitivity analysis shows that increasing the proportion of plastics in the formulation increases costs and emissions, reducing transport capacity. This work represents a straightforward approach to the design of optimal supply chains for RDF under comprehensive sustainability criteria, providing decision-makers with a set of efficient solutions to implement this energy alternative in Colombia.