Abstract

This research develops advanced fuzzy optimization models to enhance resilience and sustainability in Supply Chain Aggregate Production Planning (SCAPP) under uncertain conditions. By employing fuzzy logic, the study quantifies and incorporates uncertainties such as fluctuating operation costs and demand into production planning, enabling decision-makers to manage unpredictable changes in supply chain operations. The proposed approach prioritizes operational efficiency, risk mitigation, reliability, and sustainability, creating a robust framework to adapt to volatility and ensure a steady flow of goods.

The findings demonstrate that the innovative fuzzy optimization model significantly improves adaptability and resilience in supply chains. The model minimizes cost fluctuations, risk mitigation, optimizes resource utilization, and addresses multiple conflicting objectives in uncertain environments. Empirical results validate its practical effectiveness as a valuable tool for modern supply chain strategies, offering companies a reliable means of maintaining stability and sustainability among disruptions.

This research aligns with contemporary trends emphasizing resilient supply chain models to manage uncertainty and variability. By enhancing traditional SCAPP methodologies with advanced fuzzy and risk mitigation techniques, the study addresses critical challenges in managing uncertainty while contributing novel insights to academic literature. Key innovations include a focus on multi-objective optimization, explicit risk mitigation strategies, and the integration of theoretical advancements with practical applications. These contributions establish a new benchmark for improving the adaptability, precision, and applicability of SCAPP models, offering significant value for both researchers and industry practitioners.

Keywords: Supply Chain Management, Uncertainty, Sustainability, Resilience Index, Multi-Criteria Decision-Making, Fuzzy Linear Programming, Monte Carlo Simulation