

Design of a Supply Chain for the Reduction of Perishable Food Waste in Colombia, Considering the Regulatory Framework

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Abstract

Food waste constitutes one of the twenty-first century's most critical sustainability challenges, creating severe social, economic, and environmental repercussions. This paradox is particularly acute in developing countries, where millions endure food insecurity while massive quantities of edible resources are discarded due to inadequate institutional attention and regulatory frameworks. Although international literature on the circular economy has expanded, few studies successfully integrate logistical, legal, and social dimensions within operations optimization for emerging economies, limiting the understanding of how structural factors hinder regulatory incentives. Consequently, this research aims to design a supply chain focused on reducing meat waste through donations by addressing the specific operational and regulatory requirements of developing nations. The methodology employs a mixed approach, combining a regulatory analysis of legislation against international standards with quantitative logistics optimization models to maximize redistribution efficiency. A case study within the Colombian food sector validates this model through specific performance indicators. In Colombia, where 34% of production is wasted despite 30% of the population facing food insecurity, laws such as Law 1990 of 2019 and Law 2380 of 2024 provide tax incentives. However, a disconnect between frameworks and logistical capacities restricts recovery to only 12%. This study

contributes theoretically by bridging the gap in Food Loss and Waste literature regarding emerging economies through operations research, while practically demonstrating how adjusting supply chain designs can leverage regulatory benefits to effectively mitigate food loss.

Keywords

Food Loss and Waste, Sustainable Supply Chain, Operations Research (OR) and Regulatory Frameworks.

Biographies

Luisa Fernanda Jimenez is a master's student in engineering at the University of Antioquia, Colombia, currently completing an internship during her final semester thanks to the Emerging Leaders in the Americas Program (ELAP) scholarship at École de Technologie Supérieure, Canada under the supervision of Professor Tassed Boukherroub. Her work has focused on sustainability and the circular economy in supply chain optimization since her undergraduate studies.

Dr. Pablo Andrés Maya Duque is a professor in the Department of Industrial Engineering at the University of Antioquia. He holds a degree in Industrial Engineering from the National University of Colombia, a Master's degree in Statistics and Operations Research from the University of the Andes, and a PhD in Applied Economics (Operations Research) from the University of Antwerp. He has extensive experience in teaching optimization and in carrying out applied research and outreach projects. His research interests lie in the use of analytical tools to support decision-making, particularly in contexts with social impact.

Dr. Juan Sebastián Jaen Posada is a PhD in Systems Engineering from the National University of Colombia and is a Professor of System Dynamics and System Thinking at the Universidad de Antioquia, Colombia. His areas of interest include decision making in logistics and health care systems and circular economy.

Dr. Tassed Boukherroub is a professor in the Department of Systems Engineering at the École de Technologie Supérieure - ÉTS Montréal. She is a researcher in the field of systems engineering, supply chain management, and sustainable operations. She holds a Bachelor's degree from École Polytechnique d'Alger, a Master's degree from Université de Lorraine, and a PhD from INSA de Lyon. She has experience in developing decision-making models and applying optimization techniques to complex supply chain problems. Her research interests focus on the design of efficient and socially responsible supply chains, with particular emphasis on sustainability and the integration of circular economy strategies.