# Redesign of a Sustainable Food Bank Supply Chain

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## Abstract

Food rescue and delivery organizations target concurrently the environmental objective of reducing food waste, and the social objective of supporting underprivileged segments of the population. They secure surplus and about-to-waste food items from producers, manufacturers and retailers, and redistribute them through charitable agencies and parish councils to support the population in need of food assistance.

Inspired by the case of the Portuguese Federation of Food Banks, the study addresses the redesign of a food bank supply chain from a multi-dimensional outlook on sustainability. Considering an initial network of food banks, strategic decisions include the opening and closing of food banks, as well as the installation or expansion of storage and transport resources, while tactical decisions comprise the selection of served charities and respective assignment to the operational food banks. Moreover, product flows across the network are also to be determined.

The supply chain is formulated as a three-layer network involving the donors, the food banks, and the charities, where multiple products flow in vertical and sideways directions. Based on an extensive literature review, and supported by an in-depth field research, the problem is formulated as a dynamic and capacitated tri-objective mixed-integer linear programming model, accounting for environmental indicators such as the volume of food waste and $CO_2$ emissions, and social metrics assessing, among others, equity, inclusion, and proximity. The tri-objective problem is studied for regional and national supply chain instances, developed to depict real-life based cases. Non-dominated solutions are obtained for the regional instances appealing to the lexicographic ordering method. Relevant managerial insights are derived from the analysis of the lexicographic solutions. Three decomposition-based heuristics developed in this study proved to be effective in solving the national instances. Trade-offs between the economic, environmental, and social objectives are discussed, and properties of the mathematical programming model are proven.