

Food Security and Public Health Leverage in the Design of a Sustainable Multi-objective Food Waste Network

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Abstract

In this paper, food waste treatment alternatives are evaluated from a sustainability point of view. Using food waste characteristics as input data, we estimated the sustainable benefits such as food security, reduced human toxicity, energy utilization, and GHG emission reduction for each potential food waste processing technique. Additionally, the sustainable benefits of the closed-loop food waste network are quantified based upon geographic distance and treatment option characteristics. We formulated the food waste network framework as a strategic weighted goal programming model that aimed to minimize total costs and impact on public health while maximizing nutrition value and satisfying emissions and energy use constraints. We tested the efficiency of the proposed framework by designing a sustainable food waste treatment network for the state of Massachusetts, USA. Results showed that with a marginal increase in the treatment cost of food waste, the model has achieved zero net emissions, zero net energy use, and a competitive overall sustainability impact. Thus, by utilizing the food waste network model, policymakers can achieve the best sustainable strategies for food waste management. This study contributed to the assessment of the food waste recovery alternatives by expanding the system boundary and presenting additional key performance measures of sustainability.

Keywords : *Sustainability, Food waste, Carbon emissions, Food security, Network design*

1. Introduction

Recently Food Supply Chain Management (FSCM) is converting to more collaborative interactions between producers, processors, manufacturers, retailers, and customers rather than separate transactions. Many interrelated forces affect the food supply chain including globalization, market structure and power, consumer taste and lifestyle, technological changes, and regulations. On the other hand, the sustainability concept is concerned with improving the living quality of current societies and future generations. The three dimensions of sustainability in the food supply chain, namely economic, environmental, and social dimensions are called the three pillars of sustainability. The sustainability approach of the food supply chain aims to achieve optimal competitive advantages while maintaining social development and reducing the environmental negative impact. Within each of these three dimensions, we need to identify several parameters and factors to deal with the complexity of sustainability in the food supply chain. The three sustainability dimensions in the food supply chain are summarized in Fig. 1.

Economic Issues	Environmental Issues	Social Issues
<input type="checkbox"/> labor productivity	<input type="checkbox"/> energy consumption	<input type="checkbox"/> local farming and raw material
<input type="checkbox"/> market concentration	<input type="checkbox"/> natural resource utilization	<input type="checkbox"/> local community development
<input type="checkbox"/> import dependency	<input type="checkbox"/> environmental legislation	<input type="checkbox"/> fairness
<input type="checkbox"/> cost optimization	<input type="checkbox"/> greenhouse gas emissions	<input type="checkbox"/> employment rate
<input type="checkbox"/> revenue management	<input type="checkbox"/> waste management	<input type="checkbox"/> gender ratio
<input type="checkbox"/> inventory management	<input type="checkbox"/> water, soil, air pollution	<input type="checkbox"/> labor standards and life balance
<input type="checkbox"/> responsiveness efficiency	<input type="checkbox"/> ecological issues	<input type="checkbox"/> labor working hours
<input type="checkbox"/> packaging and product design suitability	<input type="checkbox"/> fertilizers utilization	<input type="checkbox"/> inflation
<input type="checkbox"/> consumer preference satisfaction	<input type="checkbox"/> product impact	<input type="checkbox"/> food nutrient content
<input type="checkbox"/> joint pricing	<input type="checkbox"/> substitute product	<input type="checkbox"/> food safety
	<input type="checkbox"/> traceability	<input type="checkbox"/> food access
		<input type="checkbox"/> child labor
		<input type="checkbox"/> discrimination
		<input type="checkbox"/> animal welfare
		<input type="checkbox"/> consumer health and safety
		<input type="checkbox"/> corporate social responsibility

Fig. 1: Common issues in the three dimensions of sustainability

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