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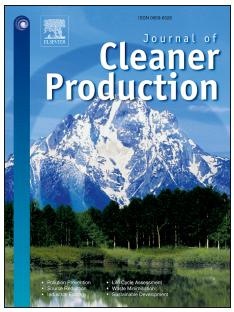

A Fuzzy Data Envelopment Analysis Framework for Dealing with Uncertainty Impacts of Input-Output Life Cycle Assessment Models on Eco-efficiency Assessment

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A Fuzzy Data Envelopment Analysis Framework for Dealing with Uncertainty Impacts of Input-Output Life Cycle Assessment Models on Eco-efficiency Assessment

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Abstract

The uncertainty in the results of input-output-based life cycle assessment models makes the sustainability performance assessment and ranking a challenging task. Therefore, introducing a new approach, fuzzy data envelopment analysis, is critical; since such a method could make it possible to integrate the uncertainty in the results of the life cycle assessment models into the decision-making for sustainability benchmarking and ranking. In this paper, a fuzzy data envelopment analysis model was coupled with an input-output-based life cycle assessment approach to perform the sustainability performance assessment of the 33 food manufacturing sectors in the United States. Seven environmental impact categories were considered the inputs and the total production amounts were identified as the output category, where each food manufacturing sector was considered a decision-making unit. To apply the proposed approach, the life cycle assessment results were formulated as fuzzy crisp valued-intervals and integrated with fuzzy data envelopment analysis model, thus, sustainability performance indices were quantified. Results indicated that majority (31 out of 33) of the food manufacturing sectors were not found to be efficient, where the overall sustainability performance scores ranged between 0.21 and 1.00 (efficient), and the average sustainability performance was found to be 0.66. To validate the current study's findings, a comparative analysis with the results of a previous work was also performed. The major contribution of the proposed framework is that the effects of uncertainty associated with input-output-based life cycle assessment approaches can be successfully tackled with the proposed Fuzzy DEA framework which can have a great area of application in research and business organizations that use with eco-efficiency as a sustainability performance metric.

Key Words: Life Cycle Assessment; Input-Output Analysis; Sustainability Performance Index; Fuzzy Data Envelopment Analysis; U.S. Food Manufacturing; Sensitivity Analysis.