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Abstract

Unveiled Sustainability: Beyond Carbon and towards a Holistic Analysis of Industrial Processes †

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The concept of sustainability has gained significant traction in recent times, permeating not only academic but also industrial fields. Unfortunately, the use of this term is often confined to carbon dioxide emissions associated with specific manufacturing processes, leading to a simplistic or partial comprehension. A deeper definition of sustainability transcends a narrow focus on carbon emissions, embracing a harmonious synthesis of economic, social, and environmental considerations. A sustainable process enhances profitability, minimizes environmental impact, and fosters positive social implications. In the contemporary landscape, processes are commonly evaluated using conventional life cycle assessment analysis. However, sustainability indicators provide an alternative and more comprehensive perspective. These indicators, expressed as percentages, find visual representation through one-shot spider diagrams. The primary objective of such analyses is to maximize the area enclosed within the spider diagram, serving as the objective function for developing a specific product. This analytical tool facilitates the evaluation of process sustainability, enabling comparisons with competitors and aiding decisions regarding the selection of raw materials based on customer needs. The integration of cutting-edge technologies like artificial intelligence (AI) and machine learning (ML) into sustainability assessments has the potential to significantly improve the precision and efficiency of evaluating complex systems. AI's ability to process large datasets and identify intricate patterns enhances the understanding of the multifaceted dynamics in sustainability, revealing subtle correlations within economic, social, and environmental factors. Meanwhile, machine learning continuously refines its models, ensuring adaptability to emerging trends and real-time changes. This technological amalgamation not only promises more accurate assessments but also signifies a shift toward informed, data-driven decision-making for a sustainable future.

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