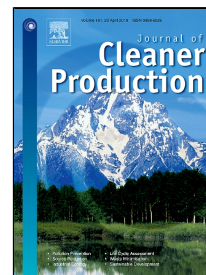


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Multi-criteria decision analysis framework for sustainable manufacturing in automotive industry

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Abstract

Increase in societal demand for sustainability has resulted in attention to sustainable manufacturing. Although an attractive goal to most, executives face difficulties in implementing sustainable manufacturing due to the necessity of balancing social, economic and environmental outcomes associated with the implementation of different manufacturing alternatives and processes. This is especially true in highly competitive consumer-oriented industries, such as the automotive industry. The literature review presented herein indicated that most of the available sustainability frameworks are qualitative in nature and limited to discussion of sustainable materials and processes, while tradeoffs between the environmental, social and economic domains of sustainability are rarely examined. To overcome such shortcomings, we develop a quantitative framework for sustainable manufacturing and illustrate its application for the automotive industry. Multi-criteria decision analysis (MCDA) is utilized to combine the values of industry executives and decision makers with performance criteria of different car manufacturing materials (ferrous metals, aluminum, plastics, organic composites, and synthetic composites). Our results show how material alternatives in manufacturing can be quantitatively selected based on sustainability objectives. Additionally, we illustrate how sensitivity analyses are used to assess the robustness of the resulting alternative selection. Although this framework may be useful for decision makers in its current form, future applications might improve the model by choosing different or more specific alternatives, using objective performance scores supported by industry research, or by investigating a more diverse set of weight distributions representing dissimilar stakeholder values.

Keywords: sustainability, manufacturing, automotive industry, MCDA, decision analysis

1. Introduction

Automobile ownership has been climbing sharply worldwide, and this trend is predicted to continue for decades (Mayyas et al., 2012; McAuley, 2003; Sutherland et al., 2004). Dargay et al. (2007) estimated that worldwide vehicle stock will increase by a factor of 2.5 between 2002 and 2030, reaching over 2 billion cars in use. Increases in fuel and resource costs, as well as societal demand for responsible manufacturing, drives constant improvement and innovation of the automotive industry due to its significant fuel consumption, resource usage, and greenhouse

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