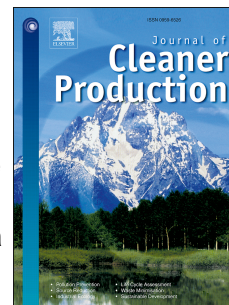


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Analyzing environmental sustainability methods for use earlier in the product lifecycle

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Abstract

Environmental sustainability information in the manufacturing industry is not easily shared between stages in the product lifecycle. In particular, reliable manufacturing-related information for assessing the sustainability of a product is often unavailable at the design stage. Instead, designers rely on aggregated, often outdated information or make decisions by analogy (e.g., a similar manufacturing process for a similar product yielded X and Y results). However, smart manufacturing and the Internet of Things have potential to bridge the gap between design and manufacturing through data and knowledge sharing. This paper analyzes environmental sustainability assessment methods to enable more accurate decisions earlier in design. The techniques and methods are categorized based on the stage they apply to in the product lifecycle, as described by the Systems Integration of Manufacturing Applications (SIMA) reference architecture. Furthermore, opportunities for aligning standard data representation to promote sustainability assessment during design are identified.

Keywords: Sustainable Design, Sustainable Manufacturing, Environmental Assessment, Analysis Tools, Lifecycle Assessment, Smart Manufacturing

1. INTRODUCTION

Manufacturing has a large impact on the environment, including high energy consumption, waste generation, and greenhouse gas emissions. Energy consumption in the manufacturing industry rose approximately 3.7 % from 2010 to 2014 from 5.38 billion kWh to 5.58 billion BTU [1]. This marked the first time since 2002 that energy consumption had risen in a four year period in the industrial sector. On top of this, American industrial facilities generate 7.6 billion tons of waste annually [2] and accounted for emissions of 6.587 billion metric tons of carbon dioxide (CO₂) equivalent [3] in 2015. This represented 21 % of all 2015 greenhouse emissions in the US, with transportation contributing 27 % and electricity

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