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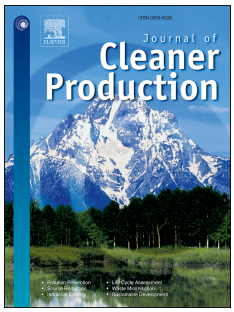

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Operations scheduling for waste minimization: a review☆

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Abstract

This article proposes a review on waste minimization at the operational level of production planning. After defining the research scope and the concept of waste minimization through scheduling, the state-of-the-art is presented. A classification based on environmental and scheduling criteria is proposed, which details the various types of scheduling problems encountered and groups them into different categories. Results show that despite having developed in the recent years, literature on waste-minimizing scheduling remains scarce and lacks a unified terminology. While research on energy-efficient scheduling has garnered a lot of attention, improving resource efficiency and reducing waste generation is also an important step towards a greener production. Thus, research perspectives for the inclusion of waste reduction concerns in scheduling are proposed based on the analysis of the literature classification.

Keywords: Literature review, scheduling, waste, multicriteria optimization, manufacturing operations

15054 words

Acronyms: 1DCSP - 1-Dimensional Cutting Stock Problem, B&B - Branch and Bound, CSP - Cutting Stock Problem, ICSP - Integrated Cutting Stock Problem, ILP - Integer Linear Programming, INLP - Integer Non Linear Programming, LCA - Life Cycle Analysis, LP - Linear Programming, LSP - Lot Sizing Problem, MILFP - Mixed Integer Linear Fractional Programming, MILP - Mixed Integer Linear Programming, MINLP - Mixed Integer Non Linear Programming

1. Introduction

Sustainable production is defined as “the creation of goods and services using processes and systems that are non-polluting; conserving of energy and natural resources; economically viable; safe and healthful for workers, communities, and consumers; and socially and creatively rewarding for all working people” (LCSP, 1998). In recent years, more and more research has been devoted to it as a possible answer to the environmental issues affecting industrial companies, such as stricter regulations, highly volatile energy prices, the shortage of raw materials and natural resources and customer demand for more environmentally-friendly products (Giret et al., 2015). Sustainable production concerns the manufacturing industry as a whole, and covers many aspects such as waste management (Memon, 2010), process planning (Shojaeipour, 2015), logistics (Govindan et al., 2015; LMI Goverment Consulting, 2003) and clean technologies (Jawahir and Jayal, 2011). Those manufacturing operations can concern both discrete manufacturing, which typically produces distinct and individual products, and process manufacturing, which transforms a mix of materials into batches of products. As a key factor in production efficiency, operations scheduling is one of several levers that can be used in order to address the aforementioned environmental issues, and without the need for high investment since no new machines are required (Trentesaux and Prabhu, 2014). Thus, by implementing more environmentally aware scheduling, it becomes easier to enable the 3R policy (Reduce, Reuse and Recycle) advocated by the European parliament (European Parliament and Council, 2008).

In their literature reviews on sustainability in manufacturing operations scheduling, Giret et al. (2015) and Fang et al. (2011) show that research thus far has mostly focused on the reduction of energy consumption; detailed reviews on energy efficient scheduling can be found in Gahm et al. (2016) and Biel and Glock (2016). Giret et al. (2015) also emphasize the need to address the outputs resulting