A PDCA-based approach to Environmental Value Stream Mapping (E-VSM)

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A B S T R A C T

Research into the application of Value Stream Mapping (VSM) as a tool to enhance the environmental sustainability performance of operations has been confined to a handful of studies only. Research on this green lean research stream is therefore limited, especially when compared to the vast amount of scholarly research focused on the ‘traditional’ VSM tool. To complement and support the narrow body of knowledge on the application of VSM as tools to improve environmental performance and enhance the effectiveness of its application, this paper proposes an approach, based on the Deming’s Plan-Do-Check-Act (PDCA) improvement cycle, to systematically implement and conduct Environmental-VSM (E-VSM) studies. The implementation of the proposed method is reported through an action research-based case study conducted in a helical rolling process of one of the mining consumables business units of an international diversified mining and materials multinational company. The results of the case study indicate that the proposed PDCA-based approach to E-VSM can be an effective alternative to improve the green performance of operations. Besides the proposal of this approach, its testing, and expanding the body of knowledge in the green lean field, the paper also contributes by providing a guiding reference for operations managers who may want to make the operations of their organisations more sustainable and environmentally friendly. Finally, this paper also intends to contribute by inspiring researchers and practitioners to broaden the study of the under-researched field which explores the application of VSM for environmental sustainability enhancement.

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1. Introduction

Since its development by Toyota in the 1940–50s, lean has emerged as one of the most dominant managerial paradigms (Forrester et al., 2010) in business environments as extensive theoretical and empirical evidence has demonstrated its effectiveness to enhance the competitiveness of organisations (Hines et al., 2004). To achieve this, lean focuses on the fierce reduction of non-value added activities, i.e. waste, and relies on an extensive set of tools and techniques. Among the plethora of tools that lean incorporates, Value Stream Mapping (VSM) is considered one of the most essential (Belekoukias et al., 2014), with Womack (2006) considering it “the most important tool lean thinkers will need to make sustainable progress in the war against muda”. VSM is a simple and visual process-based tool which enables the documentation, visualisation and comprehension of material and information flows in processes, in order to identify wastes and assist in their elimination (Nash and Poling, 2011). Over the last years, the application of VSM has not only increased within manufacturing plants and supply chains (Forno et al., 2014) but also in process industries and the service sector (Jeyaraj et al., 2013).

Underpinned by the use of VSM, and other tools and techniques,
lean has contributed to the attainment of historical and contemporary organisational objectives that include profitability, efficiency, customer satisfaction, quality and responsiveness (Garza-Reyes, 2015a). However, in order to respond to and address organisations’ sustainability challenges, the contribution of lean to enhance environmental performance and its integration with green initiatives have recently emerged as a contemporary research stream (Garza-Reyes, 2015a). In this context, the academic literature indicates that the relationship between lean and green has been studied in relation to (1) their synergies and divergences (Garza-Reyes, 2015b), (2) the potential benefits of their integration in different contexts (Franchetti et al., 2009), (3) their impact on organisational performance, and (4) their theoretical integration (Cherrafi et al., 2017).

To enable the synergies and integration of lean and green, a number of frameworks have been proposed and some of the lean tools adapted to assist improvements in environmental performance. For example, Cherrafi et al. (2017) developed a framework that methodically guides companies to integrate and implement green, lean and six sigma to improve their sustainability performance. Tomelero et al. (2017) proposed a lean environmental benchmarking method for performing a diagnosis of practices and potential sustainability improvements. Faulkner and Badurdeen (2014) presented a comprehensive methodology to develop Sustainable Value Stream Mapping by systematically following to not only document, visualise and comprehend the flows of ‘traditional’ material and information in processes but also consider their environmental dimension.

The rest of the paper is organised as follows: Section 2 presents the proposed PDCA-based approach to E-VSM and justifies the action research methodology followed in this study; Section 3 elucidates, through the industrial application of the proposed approach, the steps involved in its implementation. This allowed the systematic conduction of an E-VSM study which identified and eliminated/minimised green wastes that were present in the value stream of a manufacturing process in a case organisation. Finally, Section 4, presents the conclusions, limitations and future research directions derived from this paper.

2. Proposed PDCA-based approach to E-VSM and research methodology

An E-VSM, like the traditional VSM, should be considered a continuous improvement process where, based on the establishment of a current-state map and after achieving the proposed future-state map, subsequent future-state maps can be drawn to enable a continuous improvement cycle. As suggested by Rother and Shook (2003), VSM involves constant implementation plans for continuous improvement at value-stream level. Thus, and in order to continuously eliminate/minimise waste, Chiariini (2013) and Qassim et al. (2015) aligned the VSM approach with the PDCA cycle.

Based on this rationale, the PDCA-based approach to E-VSM implementation presented in Fig. 1 was proposed to provide an effective method to enable the deployment of E-VSM studies in a systematic, repeatable, and continuous cycle of improvement.
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