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Lean and green product development: two sides of the same coin?

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ABSTRACT

This paper compares and contrasts the lean product development (LPD) and green product development (GPD) concepts through a systematic literature review including 102 journal publications. The review resulted in 14 findings that were organised according to four dimensions: general, process, people and tools/techniques. A number of similarities between the concepts were found. For example, implementation of both concepts calls for a systems perspective where the dimensions of process-people-tools/techniques are linked holistically. Differences between the LPD and GPD concepts lie in: their goal and focus, value construct, process structure, performance metrics, and tools/techniques used. The findings do not unambiguously support that "green thinking is thinking lean" and consequently it cannot be argued that LPD and GPD are two sides of the same coin, meaning that LPD automatically leads to greener products or that GPD ensures improvements and efficiency in the product development process. However, it is reasonable to conclude that LPD and GPD belong to the same "currency". That is, the concepts share a number of similarities that indicate a synergistic relationship. This synergistic relationship has been accentuated by a nine propositions where the potential for cross-field learning is shown.

1. Introduction

"Green thinking is thinking lean". This was stated by Professor Sobek from Montana State University, USA, in September 2011 during his talk on "Sustainable production: A global challenge" at an international seminar in Gothenburg, Sweden. The talk portrayed potential synergies between the lean and green concepts. The primary message from the talk was that adopting and implementing the lean approach, with its focus on waste reduction, naturally leads to more environmentally sustainable operations. Similar arguments have been put forward by other scholars. Porter and van der Linde (1995), for example, claim that resource inefficiencies, which often occur in companies in the form of incomplete material utilisation or poor process controls, cause unnecessary waste, defects, and stored materials. From a lean perspective, such resource inefficiencies should be minimised because they do not contribute to added value. Likewise, reduction or elimination of resource inefficiencies is also sound from a sustainability perspective since inefficiencies lead to increased environmental burdens. Dües et al. (2013, p. 98) state that *"lean serves as a catalyst for green, meaning it facilitates a company's transformation towards green"*. Some empirical studies have further strengthened the notion that there exist synergies between the lean and green concepts (e.g. King and Lenox, 2001).

Nowadays, the lean and green concepts are fairly well established within both academia and industry, even though there are multiple interpretations of their meaning and contents. The origin of the lean concept can be traced back to Japan decades ago, and in particular, Toyota Motor Corporation (Monden, 1983; Ohno, 1988). The "lean" term was first coined by Womack et al. (1991) in their seminal book *The Machine that Changed the World*. A critical point in the lean approach is value creation (Hines et al., 2004), and implementation of the approach in businesses has largely focused on eliminating non-value adding activities. The green concept is one of three pillars of sustainable development, or sustainability, which was introduced in the report *Our Common Future* presented by the World Commission on Environment and Development, also referred to as the Brundtlandt Commission (WCED, 1987). In business practice as well as in much academic literature, sustainability has largely been interpreted as the concern for environmental issues in order to achieve "green" operations and products. For

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example, in their review of literature on sustainable supply chain management, Seuring and Müller (2008) found that 73% of the papers addressed environmental issues. Correspondingly, this paper also refers to the environmental dimension of sustainability.

Despite the increasing attention that has been paid to the lean and green concepts as essential ingredients in successful business operations, relatively few attempts have been made to analyse how the two concepts relate to each other. In a search for peer-reviewed papers that contained the words "lean" and one or more of the words "green", "sustainable", "clean" or "environmental", Biggs (2009) found only seven journal papers that report results where the two concepts are treated in an integrated way. This indicates that the lean and green research fields have developed relatively independent of each other. Another finding from the literature search was that the studies primarily addressed the production operations within a company. Thus, the potential relationships between lean product development (LPD) and green product development (GPD) seem to be largely neglected in literature. Only a few attempts have been made to integrate the LPD and GPD tools/techniques, for example (Chapas et al., 2010, Inoue et al., 2012). Chapas et al. (2010) developed a tool/technique based on Six Sigma factors: Supplier, Input, Process, Output, and Customer (SIPOC). A modified SIPOC tool/technique was developed and refined through discussion with participating companies. The tool/technique provides a way of thinking about sustainability that can be integrated into existing product development management tools/techniques, new product development processes, and stage-gate systems. The tool/technique developed by Inoue et al. (2012) is a preference set-based design tool/technique, which enables a flexible and robust product design under various sources of uncertainty while capturing the designers' preference based on his/her knowledge or experience. This tool/technique works as decision-making support for GPD in the early phase of the development process and considers the various design uncertainties.

It is a bit surprising that the potential relationships between LPD and GPD have received scarce attention among scholars and practitioners, since new product development (NPD) has for many years been considered to be one of the key operations that determine business success (e.g. Clark and Fujimoto, 1989), and recent research has indicated that product development plays a central role in a company's efforts to become both lean and green (Anand and Kodali, 2008; Kleindorfer et al., 2005). Although there exist literature reviews of the LPD and GPD research fields respectively (e.g. Baumann et al., 2002; León and Farris, 2011), no comprehensive review is available where the two fields are compared and contrasted. The current knowledge of potential conflicts, synergies, or overlaps between LPD and GPD is therefore poor.

Based on these premises, the starting point for this paper is the lack of insights regarding the relationships between the concepts of lean and green product development. The purpose of this paper is twofold. First, the intention is to scrutinise publications within the LPD and GPD fields to detect definitions and elements of the concepts, tools/techniques to be used, implementation issues, etc. The idea is to illuminate differences and similarities in order to allow the fields to be compared and contrasted. Second, based on the comparison between the two research fields, future promising research avenues will be suggested.

The paper is organised as follows. Following this introduction, the research approach and a descriptive analysis of the identified papers are outlined. Next, the LPD and GPD concepts are briefly introduced followed by an analysis where research on LPD and GPD is compared and contrasted. Based on the comparison, a number of propositions that reflect potential cross-field learning between the LPD and GPD fields are suggested. The paper ends with a discussion and conclusions.

2. Research approach and descriptive analysis

This section describes how the literature review presented in this paper was carried out. Additionally, a descriptive analysis is presented where statistics from the literature search are outlined.

2.1. Research approach

This study rests upon a systematic literature review, which is *"a review with a clearly stated purpose, a question, a defined search approach, stating inclusion and exclusion criteria, producing a qualitative appraisal of articles"* (Jesson et al., 2012, p.165). The systematic approach contributes to its method being both explicit and reproducible (Booth et al., 2012). The method used in this paper follows the systematic review procedure suggested by Jesson et al. (2012):

1) *Mapping the field through a scoping review:* The review plan is prepared, including specification of the method and protocol to be used for the review. This involves the definition of the research purpose and scope as well as specification of key words, databases and criteria for inclusion and exclusion of publications.
2) *Comprehensive search:* Papers are searched and collected from the specified databases using the key words and the inclusion/exclusion criteria. The outcome from the search is documented.
3) *Quality assessment:* The full papers are read and it is decided whether or not papers should be included in the review. Reasons for exclusion are documented.
4) *Data extraction:* The relevant data from the included papers are extracted and organised.
5) *Synthesis:* The data from the individual papers are synthesised into a story and tables that summarise and analyse the papers.
6) *Write-up:* A balanced, impartial and comprehensive document (a report or a paper) is written where the method and findings are presented so that the review can be replicated.

The purpose and research scope were defined on the basis of the identified lack of cross-fertilisation between the LPD and GPD fields. The fields have developed independently with limited interaction between the two. As the purpose of this paper was to compare and contrast the two fields of LPD and GPD, each field was searched separately. The following databases were used to identify relevant publications: ABI Inform (ProQuest), Scopus, Business Source Premier, Science Direct, and Emerald. A number of keyword combinations were defined to both replicate and complement other reviews in the two fields (e.g. Baines et al., 2006; Baumann et al., 2002; Ilgin and Gupta, 2010; León and Farris, 2011). The keyword combinations are specified in Table 1. The search was limited to papers where these keywords appeared in the paper title, abstract, or subject terms.

Literature was searched from January 2000 up until December 2012. This time period was selected because up-to-date literature was considered most relevant for comparison of the two fields.

Table 1
Keyword combinations for the literature search.

Lean	And Product development
Toyota	or Product design
Kaizen	
Six sigma	
Green	
Sustainable	
DFE	
Ecodesign	