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A method for sustainable product development based on a modular system of guiding questions

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Abstract

In this paper, we present a method for sustainable product development (MSPD) with the aim of integrating social and ecological aspects of sustainability with a strategic business perspective in product development. The method applies backcasting from basic principles for sustainability, which allows a strategic approach, and it includes a modular system of guiding questions that are derived by considering these principles and the product life cycle. Initial testing in Swedish companies indicates that the suggested MSPD promotes a 'bird's eye' perspective and encourages and aids development of products that support society's transformation towards sustainability. Furthermore, it is concluded that the modular system provides flexibility and user-friendliness.

Keywords: Sustainable product development; Modular system of questions; Method for sustainable product development

1. Introduction

The main sources of pollution in industrialised countries have for many substances changed from point sources to diffuse emissions from products [1,2]. It is therefore important to include sustainability aspects in decision making at the product development stage [3], especially early in the development process [4]. Once a primary product has been developed and moved to the production line, its sustainability attributes are largely fixed.

Several concepts and tools have been proposed to integrate environmental aspects into product development. Some examples of concepts are 'cleaner production', 'pollution prevention', 'ecodesign', 'design for (the) environment', 'design for recycling', and 'sustainable product development' [5]. For a review, see de Caluwe [6], van Weenen [7] and Tischner et al. [8].

In a study of ecodesign tools, Baumann et al. [9] concluded that there is too much tool development and too few studies and evaluations of existing tools. Furthermore, because of slow progress in the actual greening of products, the authors suggest that unsuitable types of tools have been developed. Related, reasons may include limitations in time and economic resources for an effective application of ecodesign tools [10,11], or there may be a lack of incentives other than the expected environmental benefit [12].

We believe there is a lack of tools or methods for sustainable product development (SPD). We suggest that SPD should be distinguished from tools that aim at environmental improvement of products within today's societal bounds. Today's 'design for environment' tools can be criticised for not considering how incremental improvements fit into a viable strategy towards sustainability. The difference between SPD and concepts such as 'ecodesign' and 'design for environment' has also been emphasised by, e.g., van Weenen [5], Roy [13], Simon and Sweatman [14], and Byggeth et al. [15]. Present ecodesign tools lack a goal defined by principles for ecological and social sustainability and strategic principles for

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sustainable development [15]. Some of today's tools and methods for considering environmental aspects have a rather vague connection to the product development process [5] and to the business dimension, which may contribute to making the incentives for ecodesign or SPD weaker.

A framework including principles for sustainability (PS) and a backcasting planning methodology, and how it can be used for a company's strategic planning towards sustainability has been presented previously [16–19]. We suggest that this framework could be combined with a standard model of a concurrent engineering development process [20] to form a method for sustainable product development (MSPD). An early version of a MSPD and the experiences from testing this method in ten small and medium-sized enterprises (SMEs) has been presented by Byggeth and Broman [21]. This MSPD attempt was based on a 'sustainability product analysis' (SPA) matrix, in which principles for sustainability and the life cycle of a product constitute rows and columns. However, trying to implement this matrix directly into a product development process turned out to be problematic in practice. Having specific questions concerning sustainability aspects included only in specific product development phases and areas of responsibility was disadvantageous. Technical consultants, e.g., do not always work with the whole development process and relevant aspects could then be missed.

The MSPD presented in this paper has a new structure, but it is based on the same theories, i.e., a model of the product development process extended over the full product life cycle, backcasting and principles for sustainability. In principle, we make use of a SPA-matrix to generate questions but in this case the questions are divided into modules to make it easier and more comprehensible to the user. The work of Hansen [10,11] has been inspiring, as well as the categorisation of sustainability aspects or improvement strategies discussed by, e.g., Fiksel [22], Brezet and van Hemel [23], and Hansen [24]. However, also these approaches lack a clear connection to a framework for strategic sustainable development.

In Section 2, we provide a theoretical description of the suggested MSPD. In the end of each subsection we present issues that we wanted to study by testing the MSPD in companies. In Sections 3 and 4, we present the experiences from initial testing of the MSPD in two companies. Suggestions for further development and improvements are discussed in Section 5.

2. A method for sustainable product development

The aim of the MSPD is to encourage and aid development of products that support society's transformation towards sustainability. The objectives are: (i) identification of potential problems of present or planned products caused by substances and activities during the product life cycle that are critical with regard to principles for sustainability; (ii) guidance in finding solutions to the potential problems by modifications of present or planned products, and (iii) stimulation of new products and business ideas based on sustainability aspects. The MSPD is designed to promote a 'bird's eye' perspective before more detailed analyses are undertaken. This is to discover essential aspects including those that are difficult to quantify, and to identify the aspects that are essential to quantify more in detail. The overview provided by the above mentioned framework could probably help avoid some detailed quantitative analyses of relatively limited relevance from a strategic sustainable development point of view.

An improvement cycle should employ at the least tools for inventory, impact, improvement and prioritisation assessment [25], all of which are covered in our suggested MSPD. Aspects to be considered are emphasised by guiding questions to the product developers. The MSPD includes one manual and three tools:

- A MSPD manual, with the aim of providing the user with the objectives and the theory of the MSPD, and instructions on how to use its different tools.
- A model of a product development process (PDP), which includes phase-specific questions for various traditional aspects within the phases.
- Sustainability product assessment (SPA) modules, which include strategic guiding questions to identify potentially critical substances and activities during the life cycle of the existing or planned product and questions to generate proposals for improvements.
- A prioritisation matrix, which includes questions to facilitate evaluation and choice among proposals. Sustainability aspects are integrated with traditional economic and technical aspects to improve the applicability of the method from a business perspective.

When a project group has read the manual, they can work with the product development questions for a particular phase. Then the SPA modules should be used. The proposals that are generated from SPA modules will be evaluated in the prioritisation matrix. The most suitable proposal(s) will be chosen before continuing working in the next product development phase. The MSPD is schematically presented in Fig. 1.

Issues that we want to study by testing the MSPD in companies:

- Can the MSPD help identify potential sustainability problems of present or planned products caused by substances and activities during the product life cycle?
- Can the MSPD function as guidance in finding solutions to the potential problems?
- Can the MSPD stimulate new products and business ideas?

2.1. A framework for strategic sustainable development

The framework for strategic sustainable development (FSSD) used in our MSPD is based on backcasting from success of the planning, i.e., from a situation of sustainability defined at the basic principle level. A backcasting perspective facilitates alignment of successive incremental improvements into viable development paths towards a sustainable society, i.e., it helps