



# Determinants of a sustainable new product development



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## ABSTRACT

Organizing and managing new product development has been perceived as challenging issues in both academia and industry for several decades. The aspect of sustainability has often been neglected in new product development although new product development allows addressing sustainable characteristics upfront in the product life-cycle. The purpose of this paper is to link sustainability and new product development by providing a conceptual framework emphasizing the interconnections of sustainability and new product development with a life-cycle and product-focused perspective. Such a link of sustainable new product development with a life-cycle and product life-cycle point of view has not been presented so far. This paper intends to elaborate on this connection, so that it leads into the subjects of new product development and sustainability, culminating in a life-cycle approach supporting a sustainable new product development. The conceptual framework indicates that it is important to involve life-cycle management, and product life-cycle management to reach a sustainable new product development. The product-focused product life-cycle management approach gives the necessary structure for a jointly sustainable new product development on grounds of cross-departmental and cross-company processes, data, and people. The factor of collaboration integrates the life-cycle-based concepts to reach a sustainable new product development. The contribution of this paper is twofold. First, it offers a novel conceptual framework of a sustainable new product development by means of product life-cycle management and thus extends current research on green new product development. Second, it provides a life-cycle management focused approach to support collaboration by complexity reduction, process harmonization, and technology.

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## 1. Introduction

The sustainability approach has gained tremendous attention since sustainable development was introduced by the Brundtland Commission in 1987 (WCED, 1987). This concept has been specified by the triple-bottom-line (TBL) approach (Elkington, 1997; Dyllick and Hockerts, 2002). One important research aspect of sustainability is the move toward more sustainable products (Moreno et al., 2011). Herewith companies face the challenge of developing sustainable products. Products are defined by their life-cycles, so that a growing branch of research is addressing product life-cycle management (PLM). Recently, PLM has gained attention in production and engineering management (Kakehi et al., 2009; Johnson et al., 2010). Consequently, the influence of PLM on establishing a sustainable NPD needs to be elaborated and is addressed here, since it seems that this integrates the full body of knowledge that is already available in the subfields.

Enterprises are encouraged to design, manufacture, and deliver products both providing new value to the customer and being sustainable in today's competitive global market. Customers demand sustainable products (Bevilacqua et al., 2007) and governmental restrictions toward products with sustainable characteristics continuously increase. Products with sustainable characteristics can constitute a competitive advantage in the market (Maxwell and van der Vorst, 2003; Campbell, 2007). Companies already claim to produce sustainable products, however, from an academic perspective these products are still considered as being inefficient regarding their sustainability criteria (Kleindorfer et al., 2005). Thus, strategies and approaches need to be detected to support a sustainable new product development.

Besides a sustainable-oriented new product development, companies are confronted with shorter product life-cycles, governmental scrutiny, and rising product complexity (Vachon and Mao, 2008; Kakehi et al., 2009; Calantone et al., 2010). Internal and external rules and restrictions to organizations influence a firm's operation management and do not facilitate approaches toward a quick and cost-sensitive sustainable new product development. Consequently, the strategies and approaches also require

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technological support to facilitate approaches toward being sustainable and to create a competitive advantage (Powell and Dent-Micallef, 1997; Ray et al., 2004).

PLMs influence on new product development is strategically based (Cantamessa et al., 2012) since the characteristics of a product are defined by integrating product processes, product data, and product-relevant people. Furthermore, technological support is entailed by PLM. The opportunity to influence a product's sustainable characteristics is prevalent in the development phase (Evans et al., 2007). Hence, analyzing the connection of PLM and sustainability might provide useful insights into a sustainable new product development approach, which this paper intends to. A connection of these approaches has not been achieved yet.

The paper aims at developing a conceptual framework of a PLM-supported sustainable new product development. This new framework helps in understanding the cornerstones of a sustainable new product development and herewith provides an important overview of the interconnection of sustainability and new product development. Existing literature of each concept is presented and constructed into a novel framework, which in itself does not compose a theory but is rather a step in theory-building (Meredith, 1993). Theory development includes conceptions, explanations, models, as well as speculation and conjecture (Weick, 1995). Explanations of the concept and the logic of the aspects involved from past work are included while not every nuance of previous works is reviewed (Sutton and Staw, 1995).

After this introduction, basic terminology on new product development, sustainability, and PLM will be presented. Section 3 explains the development of the framework. A discussion is followed by the conclusion summarizing the findings and giving implications for future research.

The following section contain several abbreviations which we intent to mention here briefly. The detailed meaning of each acronym is explained in Section 2 (Table 1).

## 2. Basics of a life-cycle approach toward sustainable new product development

### 2.1. From sustainable development to the triple-bottom-line

The well-known Brundtland Commission's definition of a sustainable development (WCED, 1987) does not provide clear guidelines for companies (Pujari, 2006; Petala et al., 2010). Thus organizations often find it difficult to identify their roles within that perspective (Shrivastava, 1995). Shrivastava (1995, p. 955) provides a more precise definition of sustainability with a strong environmental focus, referring to "the potential for reducing long-term risks associated with resource depletion, fluctuations in energy costs, product liabilities, and pollution and waste management". However, the interpretation does not include aspects of a social performance. The often-mentioned statement that the social dimension of sustainability has been neglected becomes evident here (Aguilera et al., 2007; Mu et al., 2011). Currently, the most accepted definition of sustainability or interpretation of sustainable development, is specified by the triple-bottom-line (TBL) of economic profitability, respect for the environment, and social

responsibility (Elkington, 1997; Dyllick and Hockerts, 2002). The triple-bottom-line definition is emphasized by "equal weightings for economic stability, ecological compatibility, and social equilibrium" (Góncz et al., 2007, p. 4).

Companies and researchers have realized that engineering activities require sustainable approaches in order to follow the society's growing demand for sustainably acting companies (Sarkis, 2001). Yet, literature focusing on sustainable engineering is currently limited; only few articles describe the difficulty to integrate sustainability into engineering (Ellram et al., 2007; Carter and Rogers, 2008). Nevertheless, scientists make an effort to reach a more sustainable engineering. This has mainly been done with regard to the ecological factor of sustainability (Davidson et al., 2010; Duflou et al., 2012).

### 2.2. New product development

Research in new product development (NPD) has been of interest for several decades (e.g. Wind and Mahajan, 1988; Page, 1993; Kleinschmidt et al., 2007). NPD attracts researchers being interested in engineering (e.g. Perrone et al., 2010), collaboration aspects (e.g. Emden et al., 2006), with regard to globalization efforts (e.g. Townsend et al., 2010), and green NPD (Polonsky and Ottman, 1998; Baumann et al., 2002; Dangelico and Pontrandolfo, 2010).

New product development indicates a transformation of a market opportunity and a set of assumptions about a product technology into a product available for sale with cross-functional integration and quick development cycles (Brown and Eisenhardt, 1995; Krishnan and Ulrich, 2001; Marion et al., 2012). Following a market opportunity is essential, which nowadays is asking for products with sustainable characteristics (Bevilacqua et al., 2007). Sustainable products, however, require internal and external interaction and collaboration in new product development (Tan and Tracey, 2007). Consequently, collaboration in NPD processes across companies may provide long-term advantages for a new product development (Moreno et al., 2011).

Currently, research on green new product development dominates (e.g. Salomo et al., 2010; Lee and Kim, 2011; Driessen and Hillebrand, 2012). Researchers describe that processes of product development within a company are linked to other internal processes (Baumann et al., 2002) thus requiring collaboration. Further to internal factors, there are also external influences on green product development, e.g. suppliers playing a significant role for green innovations (Lee and Kim, 2011). Collaboration is herewith extended across companies. Cross-functional collaboration among departments is seen a success factor for sustainability in NPD (Petala et al., 2010). Research shows that by going green in NPD competitive advantages can be achieved (Polonsky and Ottman, 1998). Due to the importance of environmentally responsible NPD, concepts have been created in order to support green NPD outcomes (Ellram et al., 2008). However, in order to achieve as sustainable product development, the social aspect needs to be addressed as well. It was already mentioned in the 1970s that social aspects of sustainability efforts need to be considered (Varble, 1972). Yet, the concentration on it decreased due to the strong focus on environmental improvements (Simon et al., 2000). Nowadays the importance of social factors for products and production is of greater interest than it used to be (Aguilera et al., 2007). However, it is still said that the social dimension has often been neglected (Mu et al., 2011).

Besides new product development there are further areas of research, which could well be linked to sustainability. However, in order to remain focused in this research we decided to solely use "new product development" in this research study. For the sake of completeness we added Table 2 providing an overview of further

**Table 1**  
Acronyms within the article.

NGO	Non-governmental organization
NPD	New product development
PDM	Product data management
PLC	Product life cycle
PLM	Product life-cycle management
TPL	Triple-bottom-line

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