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From 50 to 1: integrating literature toward a systemic ecodesign model

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ABSTRACT

Integration plays a key role in ecodesign, with its concept defined as incorporating environmental aspects into projects and product development process of businesses with a life cycle perspective. Assuming the lack of a comprehensive integration framework in accordance with the principles of innovation management, this study aims to fill this research gap. The research method, based on a review of the worldwide literature, used two databases and other sources, classifying and prioritising publications from primary sources. The result was a set of 52 models which was then analysed by encoding the information content according to key variables. Accordingly, a conceptual framework that combines scientific constructs and best practices with five integration principles was created. 1: a three level systemic approach (macro, meso and micro scales), integrating "top-down" and "bottom up" initiatives. 2: at macro level, strategy and goals for innovation and environmental sustainability. 3: at "meso" level, formal incorporation of environmental requirements in the product development process and portfolio management. 4: at "micro" level, implementation of customised ecodesign tools and integration of environmental aspects into project management. 5: in addition to the three levels, a transversal approach focused on change management and the "soft side" of ecodesign, emphasising the company's culture and human factors in a multifunctional vision. The conceptual model is proposed as a synthesis of main theoretical contributions found in the surveyed literature, in a systemic perspective. It is a path towards more effective ecodesign integration, building on fundamental principles of innovation management coupled with environmental sustainability knowledge.

1. Introduction

Interest in environmental sustainability and its relationship with product innovation is not new, however this concern has grown and is increasingly acknowledged as essential for organisations, as stated in an article in the Harvard Business Review (Nidumolu et al., 2009), which explains "Why sustainability is now the key driver of innovation". According to Hart and Dowell (2010) "15 years after the publication of "A Natural-Resource-Based View of the Firm" (Hart, 1995), the argument contained in that original piece has only become stronger and more relevant." However, "leading researchers have lamented that the 'revolution' has taken decades" (Goffin, 2012, p. 105). This evolution refers to ecodesign, which emerged in the 1990s as a promising approach to sustainable production and consumption (Brezet and Van Hemel, 1997).

The concept of "integration" (from the Latin "integrare", to make whole) plays a key role in the literature of ecodesign. The term appears with two perspectives: as the definition of what ecodesign is and as organisational challenges. Thus, the recent ISO 14006 standard (International Standard, 2011) determines ecodesign as "The integration of environmental aspects in product design and development, aiming to reduce adverse environmental impacts throughout the product's life cycle", whose document title is: "Environmental management systems - Guidelines for incorporating ecodesign", where the words "integrate" and "incorporate" are synonymously used. This dual use can be viewed as a consistency/alignment advantage, or as a possible confusion. Nevertheless, it explains the substantial use of the term in the literature.

However two decades after the publication of the first ISO 14000 standards, notwithstanding that environmental dimension in product innovation of companies is seen as an increasingly relevant guideline for sustainability strategies and policies, most publications still report modest results in terms of application effectiveness and scope, and also in terms of the limited effective

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integration of ecodesign and product innovation (Baumann et al., 2002; Deutz et al., 2013; Guelere, 2009; Hart and Dowell, 2010; Pigosso et al., 2013; Verhulst and Boks, 2012; etc.)

A key issue with regards to ecodesign research, whether academic or applied, remains "how to make it happen?", according to a widely cited article by Karlsson and Luttropp (2006), in the introduction of a special edition of the Journal of Cleaner Production, which included 15 articles on ecodesign.

Deutz et al. (2013) pointed to the "significant implementation gap between the theory and practice of eco-design". Since the beginning the literature has focused on ecodesign tools (Arana-Landin and Heras-Saizarbitoria, 2011; Baumann et al., 2002; Stevels, 2007), and such publications continue to increase (Rio et al., 2013). Although the theory and methods are available, in practice it appears that implementing sustainable design is not an easy task, possibly due to the lack of a holistic approach to the implementation process, from a theoretical and empirical point of view (Verhulst and Boks, 2012). Other studies corroborate this perspective, declaring that the reason ecodesign has not been consolidated in businesses around the world is mainly due to difficulties in the ecodesign management (Pigosso, 2012; Pigosso et al., 2013).

Part of the integration problem may be related to the gap between the abundant literature on new product development (NPD) and the literature on ecodesign. Goffin (2012, p. 106) warned that "Organisations need to make significant modifications to NPD processes to achieve sustainable innovation". "So adding a sustainability perspective to NPD complicates an already complex process"; and further: "Research has shown that there is a gap in many organisations between the proponents of sustainability and those who develop the products and so are responsible for implementation" (p. 110). Spangenberg et al. (2010) also highlighted the gap between sustainability and design, and regretted that "sustainability plays a minor role in design education and practice, and design is not recognised as a relevant factor in the sustainability discourse." (p. 1485).

Consequently, there is still little recognition of systemic perspectives in ecodesign research (Baumann et al., 2002). Also, insufficient attention was paid to change processes and management, which could take into account the different dimensions of the company's Product Development Process (PDP) (Goffin and Mitchell, 2010; Rozenfeld et al., 2006).

As a starting point this article assumes there are still gaps in ecodesign literature about implementing a systemic change management approach, which considers the interaction of environmental issues with the various dimensions of the PDP. To deal with this research gap this article tried to address the following questions:

Q1: What is the scientific state of the art for the integration of ecodesign and PDP in companies?
Q2: Are there available and complete models to direct such integration? How are these models characterised? What are their main variables and relationships?
Q3: How do the existing models converse with the most accepted PDP models in companies?
Q4: What requirements and propositions can be prepared in terms of scientific concepts (Questions 1–3) to guide the development of a conceptual model in order to leverage the integration of ecodesign in companies?

These issues were addressed using the methodological approach of a systematic literature review.

This article is structured in five sections. Section 2 presents the methodology that was followed, detailing the protocol for the literature review. Section 3 contains the results of the bibliographic review. The following sections show the discussion of the models found (4) and propositions for building a more complete model (5) and the conclusions and limitations (6) of this broad study on best practices in the literature directed to the business context.

2. Research methods

The chosen methodological approach is a systematic literature review, striving for an overview of the state of the scientific art of ecodesign integration, focussing on previously published models.

The systematic review followed the three steps of the process suggested by Tranfield et al. (2003): data collection, data analysis and synthesis. Synthesis is the step that most adds value to a review as it generates new knowledge based on complete data collection and meticulous analysis (Crossan and Apaydin, 2010, p. 4). Several qualitative and quantitative methods can be used to help review the literature, such as the bibliometric approach, meta-analysis and content analysis (Carvalho et al., 2013); the latter was chosen for this work.

This work focuses on analysing the literature on the subject of ecodesign integration. Due to the scope of the subject, such review entails several challenges, which were categorised into three topics: aligning the vocabulary, dispersed literature and organisational aspects and macro processes taken into account. These challenges, which are discussed at the beginning of this section, justify our methodological choices.

- Aligning the vocabulary

In the sphere of environmental sustainability, though the term ecodesign is widespread and substantiated by ISO 14006-2011 (International Standard, 2011), similar terms are still used. For example, in the United States the term "design for environment" (DFE) is preferred and ecodesign is less used as it has a restrictive connotation associated with aesthetic design. The multiplicity of terms used for the concept and its expansion create search difficulties in the databases and compromises the quantitative research assessments. However within a comprehensive interpretation, several expressions have equivalent meanings, with the possibility of being interpreted differently depending on the authors.

- Dispersed literature

There are still few publications on ecodesign specifically targeting innovation management (Stevels, 2007). Yet, there is a scientific work on ecodesign that addresses "Environmental Management", as for instance through the concept of POEMS: Product Oriented Management System (Donnelly et al., 2006). There is also a series of publications dedicated to eco-innovation, a term which can lead to multiple interpretations.

- Organisational aspects and macro processes

According to the introduction, this work follows a proposal directed to a systemic approach to sustainable innovation, with the life cycle perspective (extended supply chain). This outlook leads to strongly consider other business processes interacting with PDP, such as sustainability management and supply chain management. Therefore, the search for information and publications should exceed the boundaries of the product innovation management area (search scope, keywords, etc.), aimed at careful consideration to elaborate an ecodesign integration model in the future.