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Reviews, action and learning on change management for ecodesign transition

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ABSTRACT

Corporate sustainability, which has become essential to most companies in the last decades, stipulates that environmental requirements should be incorporated into diverse business processes. To effectively integrate environmental aspects into product innovation processes, companies might have to significantly change some of the practices and habits of all the stakeholders involved and of the organisation. To complement the extensive literature on the (technical) "hard side of ecodesign", this article explores the promising "soft side", which considers company culture and human factors, by a multiple step literature review associated with a longitudinal action research in a large cosmetics company. Although a consistent prescriptive change model is still lacking in ecodesign literature, a strong convergence and complementarity is observed between the previous conclusions on ecodesign integration models and the emerging Transition Management approach designed for the sustainability issues faced by organisations. As a result, an "ecodesign transition framework" is proposed by combining a three-level systemic approach, considering both top-down planning and bottom-up innovation, with new types of interaction and dynamic cycles of action and learning, with a deep stakeholder management. This new framework was developed and positively applied to the company in a five-year experience to face the complex transition process, thus advancing the knowledge from social science for innovation and sustainability management challenges. Such approach could positively address change management issues and help companies evolve toward a more effective sustainable product innovation process, in the context of evolving business management practices that require progressive change and more human-based strategies.

1. Introduction

Along the last two decades, corporate sustainability has become more global and fundamental to the success of most companies, evolving from expressing good intentions to addressing critical business issues linking economic, social and ecological performance (Kiron et al., 2015). Such "megatrend", directly affecting the competitiveness and even the survival of the organisations, entails companies to update traditional business tools to consider the specialised requirements of environmental sustainability (Lubin and Esty, 2010).

Ecodesign has emerged in the 1990s, defined as the integration of environmental aspects into product development, with the aim of reducing environmental impacts of products throughout their life cycle (Brezet and Van Hemel, 1997; Charter and Tischner, 2001). "Design for sustainability", or other similar designation, has been recommended for supporting companies to face the ever growing environmental and social pressures and to meet customers' needs - therefore responding to the increasing demand for sustainable product design (Fargnolia et al., 2014). The traditional focus of ecodesign refers to product innovation processes, as acknowledged in the ISO 14062:2002 standard (International Standard, 2002). More recently, in the ISO 14006: 2011 standard, ecodesign also involved a broader scope of innovation within an organisation (International Standard, 2011).

According to Vogtlander et al. (2013), the greening of products of existing companies is far more promising for a fast transition towards sustainability than the start-up of new companies with new green products. However, most companies still face substantial challenges for dealing with the effective implementation of ecodesign principles and tools into their product development process (PDP) and related activities, as confirmed by recent studies and

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surveys (Brones and Carvalho, 2015; Brones et al., 2014; Wolf, 2013).

To interpret this situation, researchers have suggested that a potentially excessive emphasis was given to the technical aspects or the "hard side of ecodesign", essentially deriving from the field of industrial design, engineering and environmental sciences. Most ecodesign research and literature predominantly addressed the hard side, focusing on tools and based on theoretical academic experiences or pilot projects (Charter and Tischner, 2001; Stevels, 2007).

Hence, commonly recommended approaches resulting from the hard side have been questioned as poorly relating environmental activities with other business aspects, besides lacking a more systemic perspective (Baumann et al., 2002). This approach often led to little "change in practice" (Boks, 2006). Thus, a gap regarding how to deal with the non-technical aspects has been pointed out in the literature, which gave rise to a novel research trend named the "soft side of ecodesign", an expression coined by Boks (2006). To fill the gap of soft aspects of ecodesign toward more systematic and durable application at firm level, new propositions are necessary to address recurrent challenges observed in numerous studies, and to complement previous research toward a more systemic and effective incorporation of environmental sustainability into the product innovation process at company level (Brones and Carvalho, 2015).

Changes towards sustainable consumption and production are recognised as fundamentally complex (Tukker et al., 2008b). The road to sustainability requires a joint search agenda that entails a process of mutually enforcing actions for change (Tukker et al., 2008a). Sustainability has been named a "wicked problem" that requires an essential change in the whole system (Schäpke et al., 2013). Such situation will only be resolved by systemic changes involving technology, economy, culture, ecology, institutions and organisation (Loorbach and Wijsman, 2013). A new change management concept is necessary to evolve towards the "eco-innovation paradigm", where life-cycle thinking and ecodesign would be two key principles for decoupling growth and degradation (De Vries and te Riele, 2006).

Companies can design and analyse their eco-innovative initiatives with respect to specific focus areas (also called "targets)", the type of progress being made (mechanisms), and the resulting effects (impacts). These targets include process, product, marketing methods, organisational and institutional level (OECD, 2009).

Ecodesign clearly has its place among such eco-innovative strategies, and can combine developments leading to cumulative 'incremental' innovation and improvements, and those having a potential of contributing to 'radical' or system innovation. Their combination may be necessary to tackle the huge challenges associated with sustainability (Elzen et al., 2004).

Following such views, change accompanying ecodesign integration could be seen as a process to be constructed, and not only as a result of the expected progress associated with the imposed adoption of more sustainability-adapted technical practices. According to McDermott et al. (2008), academics and practitioners interested in change processes will find an extended literature, but also complex and fragmented.

To face this complexity, European researchers have argued that new concepts were necessary for sustainability transitions, defined as long-term, multi-dimensional, and fundamental transformation processes by which established socio-technical systems shift to more sustainable modes of production and consumption. Transition Management (TM) has emerged as one of the main research strands in this context (Markard et al., 2012), initially applied at the macro level, as part of the national sustainability policy in The Nederland's (De Vries and te Riele, 2006).

The TM concept has been built on the complex systems approach, new forms of governance and social theory, and was translated into descriptive and prescriptive models (Kemp and Rotmans, 2005); Kemp et al., 2007; Loorbach, 2007). Major and complex transformations are required to address the important societal problems involved in sustainability in a broad sense. Such transformations are called 'transitions' or 'system innovations' and involve changes in a variety of elements, including technology, regulation, user practices and markets, cultural meaning and infrastructure (Elzen et al., 2004).

However, empirical knowledge, based on practical experience, needs to be developed (De Vries and te Riele, 2006), and TM is only emerging at company level (Loorbach and Wijsman, 2013), since it initially came from a broader societal and systemic perspective.

Therefore, pursuing the goal of formulating a framework capable to help companies evolve toward more sustainable product innovation processes, this paper explores and deepens the soft side aspects of ecodesign. Both change management and transition management potential application are considered for ecodesign integration, in order to address organisational, human and temporal transformations needed to operate such evolution at firm level. The aim of this paper is to bring new insights and propositions linking knowledge from operations and environmental management with general and recent social theories. Also, these propositions should be consistent with real long-term in-company experiences, which could be addressed by action research, considering that change is a key component of action research approaches (Burnes, 2004).

Hence, this research intends to build a relevant part of new ecodesign integration principles based on a multistep literature review, a synthesis of previous scientific recommendations, and an analysis of empirical observations in real company conditions. To present this construction, the article is structured into six parts. Section 2 summarises the different research methods used. Then, the central sections develop the results of the multistep bibliographic reviews conducted from several perspectives and leading to the proposition of the "ecodesign transition" concept (3), and show the application of these propositions to the context of a field experience (4). The following section (5) discusses the results and propositions before the concluding remarks and perspectives (section 6).

2. Research methods

This section presents the different research methods used, starting with an overview of the research approach and design; then, it shortly describes how the literature reviews and action research were conducted.

2.1. Overall methodological approach

This paper explores the soft side of ecodesign integration, considering change and transition management approaches to deepen and to complement previous researches. For this, several phases of reviews of the existing literature on ecodesign management, change management, and sustainability transition were used, as represented in Fig. 1. These theories were analysed and confronted with the experience of a longitudinal study conducted in an action research (AR) within a consumer goods company. Such approach follows "the theory-building process [that] occurs via recursive cycling among the case data, emerging theory, and later, extant literature" (Eisenhardt and Graebner, 2007, p.25). Consequently, this article combines a multistep literature review and analysis (steps 1 to 4), with an action research approach (developed in two cycles), as briefly shown in Fig. 1 and described in the following sections.

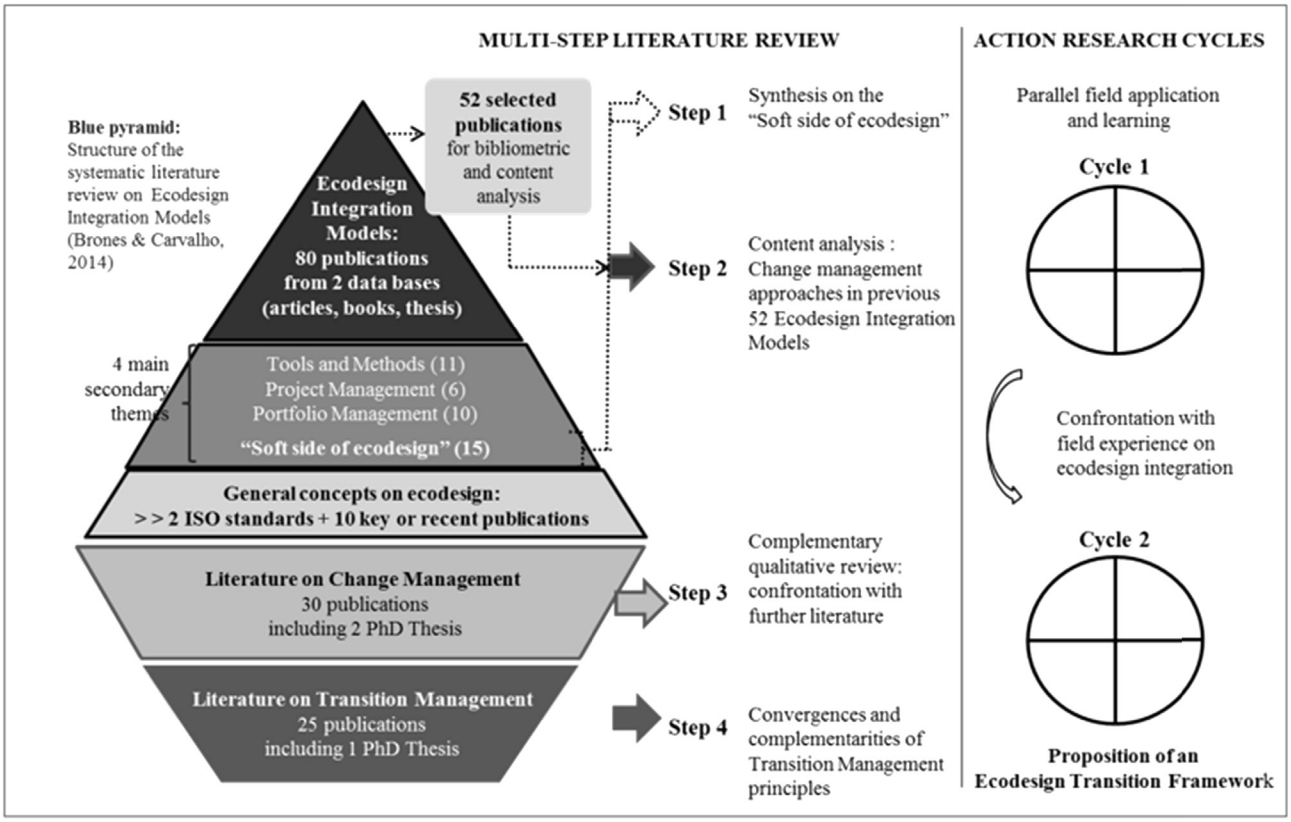


Fig. 1. Research design.

2.2. Multistep literature review

As a starting point, the challenges and basic principles associated with the "soft side" of the ecodesign management were analysed in the established ecodesign literature (step 1).

Step 2 furthers the soft dimension of a previous systematic review, following Webster and Watson (2002) recommendation, in search of a thorough understanding of the literature considered. The previous review had given an overview of the state of the scientific art of ecodesign integration, focusing on previously published models (Brones and Carvalho, 2015) and led to the proposition of a systemic ecodesign integration model. Additional bibliometric techniques and content analysis were used in this complementary study, including simple statistical treatments and graphs to analyse the content of internal information, after encoding with the main constructs identified in step 1.

The management approach of integration was encoded in order to analyse their distribution and evolution (Carvalho et al., 2013). This set of models, considering a relevant sample of the ecodesign integration literature since the 1990s, was studied in depth taking into consideration the "soft side" integration approaches cited in the models and the associated content of the articles, so as to systematise and to synthesise the contributions to the research topic and to enable to discuss the key constructs found. The publications were also classified according to their level of perceived relevance to this specific study.

To better understand how human aspects can be considered for ecodesign implementation, step 3 explores the complementary qualitative reviews conducted on change management approaches, from different trends of the social sciences.

Step 4 explores an additional layer of publications through a specific search on the new concept of Sustainability Transition and Transition Management. This process, linking to the conclusions from previous researches, led to identifying new propositions and recommendations for ecodesign integration seen both as a business objective and a research object.

The main sources and references for the reviews conducted on change management issues in steps 1, 3 and 4 are listed in Table 1. Within the different sources, the main data collected (content analysis and field data) were classified, clustered, and organised using affinity diagrams, suitable for dispersed data (Fleury et al., 2016; Mohamedally and Zaphiris, 2009). A five-step bottom-up sorting procedure was used: (1) determine the theme; (2) gather the data; (3) sort the data into clusters; (4) choose the heading, and (5) draw the finished diagram with blocks of information. This procedure led to the proposition of the framework as a synthesis of the four complementary sources, including the main constructs identified from the conclusions of the reviews and content analysis, and interpreted within the company field experience.

In a parallel perspective, following the AR principles and methods, such propositions were considered in an applied field study on ecodesign integration as presented in the next section.

The main references are in bold.

2.3. Action research approach

Albeit increasingly recommended in Operations Management (OM), AR has scarcely been documented for ecodesign studies (O'Hare, 2010), as confirmed by searches in the Scopus database, with less than ten studies using AR in the field during the last 20 years. However, this method should be considered mature, since Lewin and his colleagues coined the expression and principles in the 1940s as a way of learning about organisations by trying to change them (Lewin, 1946).

Table 1
Main sources and references for change management issues (steps 1, 3 and 4).

	Ecodesign management/soft side		
Step 1	Boks, 2006; Boks, 2008; Charter and Tischner, 2001; Cohen-Rosenthal, 2000; Jabbour, 2013; Jabbour et al., 2013	Kerga et al., 2011; Lenox and Ehrenfeld, 1997; Lofthouse 2003; Lofthouse 2004; McAloone and Evans, 1999; Murillo-Luna et al., 2011	Petala et al., 2010; Stevels, 2007; Verhulst, 2012 (R) Verhulst and Boks 2012; Verhulst et al., 2007; Zahari and Thurasamy, 2012
Step 2	See Section 3.2: analysis of 52 references with integration models (selected from an initial pool of 80 references identified in database searches and a recycling process of other publications)		
Step 3	Organisational theory Barley and Tolbert, 1997; Bascoul and Moutot, 2009; Bititci, 2007; Burnes, 2004; Ehrenfeld, 2008; Ford and Ford, 2010; Giddens, 1984; Groysberg and Slind, 2012; Loorbach et al., 2009; **Verhulst, 2012 (R); Vladimirova, 2012 (R)**	Behavioural theory Ajzen, 1991; Amabile, 1993; Armitage and Conner, 2001; Gollwitzer, 1999; Guagnano et al., 1995; Ibtissem, 2010; Kahneman et al., 1991; Mazar and Zhong, 2010; Ones and Dilchert, 2012; Osbaldiston and Schott, 2012; Prochaska and Di Clemente, 2009; Prochaska et al., 2001; Rise et al., 2003; Ryan and Deci, 2000; Stern, 2000; **Szeler and Melberg, 2014 (R);** Unsworth et al., 2013	Nudging Dolan et al., 2011; Hausman and Welch, 2010; Johnson et al., 2012; Oullier and Sauneron, 2011; **Szeler and Melberg, 2014 (R)**
Step 4	**Transition management** Boons and Wagner, 2009; Buysse and Verbeke, 2003; De Vries and te Riele, 2006; Elzen et al., 2004; Geels, 2005; Geels and Schot, 2007; Kemp and Rotmans, 2005; Kemp et al., 2007; Kern, 2012; **Loorbach, 2007 (R); Loorbach, 2010**; Loorbach, and Rotmans, 2006; Loorbach and Wijsman, 2013	Loorbach et al., 2009; Markard and Truffer, 2008; **Markard et al., 2012 (R);** Mulder, 2007; Murmann, 2003; Roome and Wijen, 2006; Rotmans and Loorbach, 2006, 2009; Ryan, 2004; Schäpke et al., 2013; **Seuring and Müller, 2008 (R)**	Sondeijker et al., 2006; Steurer, 2006; Stubbs and Cocklin, 2008; Tukker et al., 2008(a); Tukker et al., 2008(b); Van der Brugge and van Raak, 2007; Van Kleef and Roome, 2007; Verhulst, 2012

(R) = Review from the previous literature on the subject.

Westbrook (1995) claimed that AR, although it can be seen as a variant of case research, brings a real new paradigm to research in OM, which Coughlan and Coghlan (2002) later developed, arguing its relevance and validity to address the operational realities experienced by practicing managers while simultaneously contributing to knowledge. According to Karlsson (2002), "there are incomparable potential benefits of deep insight also on causality and the possibilities of experiments on the field are rather unique. This will well compensate for criticism for lack of generalizability". However, different approaches, applied to research on change, have been subject to severe critiques regarding their neglect of the context and the process of change, as well as of the relationship between researchers and practitioners within the research process (McDermott et al., 2008). According to specialists, AR was claimed as especially suited to organisation change projects (McDermott et al., 2008; Williander and Styhre, 2006).

For quality AR, Thompson and Perry (2004) recommended including two related but distinct views – the core in-company field research project and the generalising research project. Accordingly, this research combines general AR principles and specificities from Insider Action Research in a longitudinal study to capture the change and transition aspects of the soft side.

The field research was performed along five years, within a study associating the University of São Paulo and a leading Brazilian cosmetics company - the first author of this article being with both organisations, in a situation characteristic of an insider action researcher (Coghlan, 2007; Holian and Coghlan, 2013).

The company has been recognised by different types of stakeholders in Latin America for its strong commitment to sustainability, as embedded in the company's values and identity (Sahota, 2014). In line with these commitments, the firm has launched a company-wide ecodesign program in 2011. The company had already implemented a number of corporate and product initiatives towards reducing associated environmental impacts for several decades, but had not yet considered ecodesign in a systematic way.

This program, or the applied side of the AR study, allowed a change management experiment in real field conditions, and was conducted in two implementation cycles of planning, action, and fact-finding concerning the result of the actions (as recommended by Coughlan and Coghlan, 2002), conducted from 2011 to 2015. The main activities, led within cycles 1 and 2, followed a "Plan-Do-Check-Act-like process" for selecting, customising and implementing ecodesign practices considering both hard and soft sides. This article exploits the change management aspects of the experiment.

The summarised results were based on multiple sources of data and evidences collected during the five-year period, including several sets of workshops and individual interviews from different publics within the company (from different functions and hierarchical levels), observations during tool development and applications, and along eight associated product development projects. Also, a meta-analysis and the monitoring of the AR was conducted at different stages and between cycles (Coughlan and Coghlan, 2002), using an Ecodesign Maturity assessment (Pigosso et al., 2013) as well as formal presentations and discussion of on-going work and partial results in international conferences and with academic experts from several Brazilian and European Universities. Data analysis included triangulating different sources, critical analysis and confrontation with previous theory in search of stronger validity for such a reflexive, collaborative and interventionist study typical of AR (Coghlan, 2007).

3. Results

In this section, the results from multistep literature reviews conducted on different aspects of ecodesign soft side and change management issues are synthesised, leading to the emergence of an ecodesign transition framework.

3.1. Learning from the "soft side of ecodesign"

The concept "Soft Side of EcoDesign" has been formalised by Boks at Delft University of Technology, referring to a variety of sociological, psychological and even intangible factors that ecodesign research should address (Stevels, 2007). Stevels narrated how this innovation was presented at the Electronics Goes Green

Conference in Berlin in 2004, with the provoking title "EcoDesign in Industry is not an Environmental Issue": "It shocked part of the audience but it was an eye-opener for some participants as well" (Stevels, 2007, p.176).

Based on a literature review, Boks (2006) concluded that previous publications did not provide enough insight to understand the role of socio-psychological factors in the context of ecodesign operationalization. Additionally, he identified the main perceived success factors and obstacles for the dissemination of ecodesign information from a series of interviews with major electronics multinationals in Japan and South Korea in 2003, and concluded that the most important hurdles appear to reflect more social-psychological issues: the gap between proponents and executors, organisational complexities, and unwillingness to cooperate (Boks, 2006).

Going back to its origins, ecodesign management and organisation principles have emerged as secondary insights to the (technical) principles of ecodesign consolidated during the late 1990s. For example, Lenox and Ehrenfeld (1997) explored the "environmental design capabilities", based on a literature review and four case studies. In an exploratory study on implementing ecodesign principles in several companies, McAloone and Evans (1999) introduced the overall concept of an observed sequence of change facing change management issues. Charter and Tischner (2001) featured that it is "important to consider 'soft factors' such as organisational structure, systems, communications and corporate culture", and that 'soft issues', aimed at gaining involvement from business functions, are essential to address.

Nevertheless, this trend has further progressed relatively slowly, even after Boks' initial studies. For instance, Kerga et al. (2011) argued that companies should develop capabilities and resources to face these challenges. This view is also found for the "greening of companies" more broadly, recognising that technical changes related to environmental management require human and organisational commitment (Jabbour et al., 2013).

Ecodesign integration can follow top-down approaches driven by management leadership, or alternatively bottom-up initiatives - technical projects emerging from the field (Charter and Tischner, 2001; Stevels, 2007). Complementary knowledge should be brought from the social sciences to wider change management perspectives, consequently rising novel and more effective approaches on ecodesign integration, strongly connected to industrial contexts. These new trends will be explored hereafter, identifying the main constructs and bringing theoretical references from other disciplines.

3.2. Change management approaches in previous ecodesign integration literature

The content referring to change management has been recently analysed in the corpus of 52 integration models, by an in-depth analysis conducted by Brones and Carvalho (2015), in a systematic literature review. Table 2 presents the compilation of these approaches encoded following the main types of integration approaches as commonly discussed in the literature (top-down, bottom-up, or mixed). The references were also classified according to their level of alignment with the purpose of this research, i.e. if they introduced instructive integration principles in one or in several of the dimensions considered (systemic levels, consideration of innovation management principles and detailed change management approaches).

The analysis reveals that 44% of the models do not consider change management issues at all, which confirms the general priority given to technical aspects. Then, the most common approaches recommend top-down ecodesign implementation or mixed approaches (23% each), more frequently than bottom-up integration (10%), as indicated in Table 2.

Additionally, Fig. 2 represents the evolution over time of the change management approaches considered in the 52 models. This distribution does not show an increase of any particular type of approaches along time. The first mixed approaches have been mentioned since 2000, but they have not increased in more recent publications. The qualitative content analysis of these publications is summarised in Table 3.

In the 52 models, several important barriers or success factors associated to change management principles were mentioned. For the top-down strategies, for example, the risks of inter-functional conflicts, multifunctional implementation team with top management support, and goal setting are important issues. From bottom-up initiatives, awareness raising and training, pilot or demonstration project, new behaviours needed combining creativity and motivation, multi-stakeholders networking and action learning are a set of propositions for successful ecodesign integration. Even if some sensible general advice is provided (e.g: "need for systemic transition with technological, social and cultural changes; importance of inter-disciplinarity", by Vezzoli and Manzini, 2008), the change management recommendations from these models appear quite fragmented and lack an organised and coherent structure.

From this content analysis, it was concluded that the change management perspective is a secondary perspective for most of these models, except for Verhulst and Boks (2012), which represents the recent expression of the "soft side" research trend. This was the only model of the group analysed that was specifically built toward this dimension of the ecodesign integration challenges.

Verhulst and Boks (2012) is a circular framework primarily based on Levin's three-stage change process (unfreezing, changing and refreezing). The authors presented it as a descriptive model, with limited prescriptive function, as confirmed in Verhulst's PhD thesis (Verhulst, 2012), recommending further research in this direction.

Hence, it is difficult to raise any convergences or tendencies from the diversity of suggestions indicated in this fragmented set of models and publications. Above all, this corpus of ecodesign literature provides almost no indication on how to conduct and to follow up these change management processes, and does not report detailed application examples of this field experience. Finally, this overview confirmed that the arena of change management for ecodesign integration is still a challenging issue where other knowledge and experiences could be more deeply explored from social sciences standpoints.

3.3. Bringing additional knowledge from the change management literature into the specific challenge of ecodesign integration

In order to consolidate and to complement previous findings, a wider qualitative review of the literature on change management brought additional knowledge from the social science theories to give rise to novel insights applicable at firm level.

Promoting change in organisations is recognised as a complex task, as seen from failure rates of change projects estimated between 50 and 80% (Ford and Ford, 2010; Verhulst, 2012; Vladimirova, 2012). According to Boks (2006), change management mainly has to face individual and organisational resistance to change processes.

Other important organisational theories brought the fundamentals for understanding the dynamics of organisation changes, such as the structuration theory (Giddens, 1984), which states that societal change arises from of the interaction between actor and structure. In fact, structure is both a medium and an outcome of human practices and activities within organisations: Giddens'

Table 2
Classification of change management approaches in the 52 ecodesign models.

Change management approach	Not addressed	Bottom up	Top down	Bottom up + top down	Total
# of Models (1993–2012)	23	5	12	12	52
% of Models	44%	10%	23%	23%	100%
References					
Higher alignment	Van Hemel, 1998.	Hassi et al., 2009.	Dewulf and Duflou, 2004; Goffin, 2012; Hermenau et al., 2005; Ölundh, 2006; Pigosso, 2012.	Crul et al., 2009; Handfield et al., 2001; International Standard, 2002; Kara et al., 2005; Ritzén, 2000; Stevels, 2001; Verhulst and Boks, 2012.	
Medium alignment	Alakeson and Sherwin, 2004; Baumann et al., 2002; Berchicci and Bodewes, 2005; Robèrt et al., 2002; Van Hemel and Cramer, 2002.	Fiksel, 1993; Vezzoli and Manzini, 2008;	Ammenberg and Sundin, 2005; Donnelly et al., 2006; Hallstedt et al., 2010; International Standard, 2011; Jeganova, 2005.	Bhamra, 2004; Le Pochat et al., 2007; Simon et al., 2000; Tingström, 2007.	
Lower alignment	Bovea and Pérez-Belis, 2012; Bucci et al., 2012; Dusch et al., 2010; Ferrer et al., 2012; Ghazilla et al., 2008; Howarth and Hadfield, 2006; Jones et al., 2001; Keskin et al., 2013; Lewandowska and Kurczewski, 2010; Neal and Heintz, 2001; Nowosielski et al., 2007; Poyner and Simon, 1996; Ramani et al., 2010; Spangenberg et al., 2010; Trappey et al., 2011; Waage, 2007; Yang and Song, 2006.	Carrillo-Hermosilla et al., 2010; Lofthouse, 2006.	Arana-Landin and Heras-Saizarbitoria, 2011; Sherwin and Bhamra, 2001.	Kengpol and Boonkanit, 2011.	

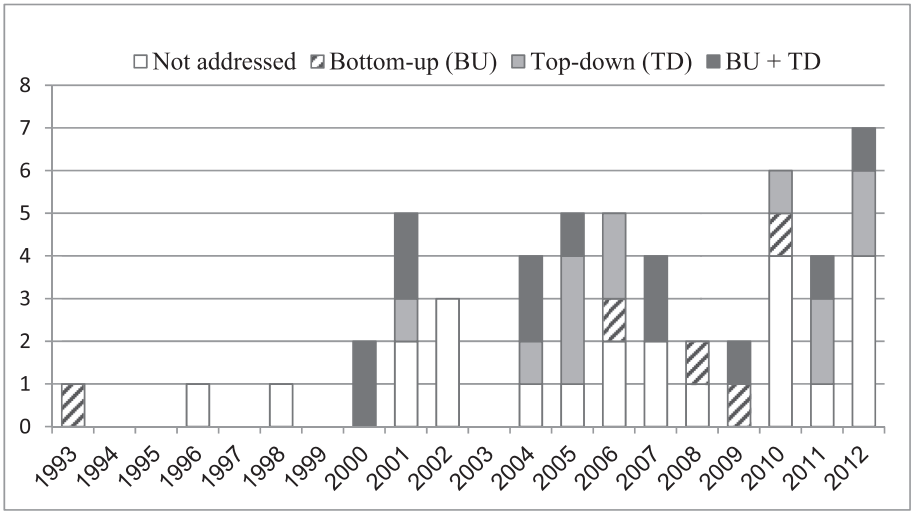


Fig. 2. Evolution of change management approaches in ecodesign models (1993–2012).

theory argues that the structure that creates routine is continuously embedded in the culture in the course of the action that creates structures. This structuration theory was completed by the institutionalisation theory (Barley and Tolbert, 1997), deepening the links and the dynamic process between new practices and action structure in organisations, besides detailing the structuration process with methodological guidelines.

A key concept from organisational studies, the "status quo bias", states that people are reluctant to change owing to the disadvantages of leaving the current situation appear greater than the advantages of changing. More recently, social scientists have brought new insights on behaviours to overcome this barrier, seen as a key challenge and opportunity to evolve to a successful change (Ford and Ford, 2010).

Several authors tried to bring organisational change management approaches to sustainability programmes, using the Change Wheel Model (Kanter), including nine drivers, or the Morgan Model, based on three essential steps: change intentions and attitudes; define and shape target behaviours; and structure means to obtain the behaviours. In her review, Vladimirova (2012) compared different models addressing the process of change (How). The original model by Lewin is still a major reference, but should not be seen separately from the other three elements, which comprise his "Planned approach to change", i.e. Field Theory, Group Dynamics and Action Research (Burnes, 2004).

Verhulst (2012) study on the human side of sustainable design implementation from the perspective of change management approached change at an organisational level, although she recognised that this evolution would also require changes in behaviour at a personal level. Organisational change management intends to take an organisation through the transition from today to a new future state. A successful enterprise transformation requires a holistic and systematic approach that crosses organisational boundaries and integrates viewpoints from multiple stakeholders,

Table 3
Change management approaches in ecodesign integration model: synthesis of the classified content. (main observations indicated in bold).

Bottom-up	Top-down	Bottom-up + top-down
• Transformational change towards sustainability require **people** with adapted **profiles** (e.g. profile T) and new **behaviours**: creativity, motivation, multistakeholders networking (Hassi et al., 2009) • Need for systemic transition with technological, social and cultural changes; importance of **interdisciplinarity** (Vezzoli and Manzini, 2008) • Providing **information** to support ecodesign education to build up **tacit knowledge** for designers. Importance of meeting the cultural requirements of designers (Lofthouse, 2006) • Develop new **capabilities** incrementally to ensure that they are properly adapted to the **culture** and existing organisational processes (Fiksel, 1993)	• Top management role; risks of **inter-functional conflicts** (Goffin, 2012) • **Awarene**ss raising and **training** included in management practices (Pigosso, 2012) • Top management role; ensure **cross-functional** approach and involvement of the whole value chain; promote internal and external **communication** (International Standard, 2011) • Senior management role with **incentives,** systematic **control,** and indicated tools. Importance of **communication** between organisational levels with a common language (Hallstedt et al., 2010) • Top-down approach to **deploy Strategy** to the projects (Ölundh, 2006) • Environmental policy driver for implementing and improving management system (POEM). Top management **support**; management group provides qualified personnel, technology and financial **resourc**es for implementation and continuous improvement; **mandatory e.learning** program (Donnelly et al., 2006) • Group of people responsible for transferring Life Cycle Design into company practices; generate sufficient **knowledge**. (Hermenau et al., 2005) • Top management **suppor**t; **cross-functional** teams; education and **training**, support of environmental specialists (Ammenberg and Sundin, 2005) • Main driving force**: commitment** and motivation of senior management. Internal motivators: **knowledge, communication**, attitude, and environmental awareness (Jeganova, 2005) • Importance of sustained management **support** (Dewulf and Duflou, 2004)	• Paths and approaches **depend on the company**; 3 main human factors: employees' **participation**, **training**, **resistance to change** (Verhulst and Boks, 2012); • **Multifunctional** implementation team with top management **suppor**t starting with **pilot**/ demonstration project (Crul et al., 2009) • Demonstration **pilot** with **external experts** support, bringing expertise and helping in the initial change; focus on the R & D department, involving other functions (Le Pochat et al., 2007) • Need to develop an "ecodesign mentality", involving **motivation**, commitment, **learning**, education and creativity; the importance of high and middle management support (Tingström, 2007) • Top-down approach associated with the practical application, bottom-up with simplicity. Different users/level: designers; product manager; senior management (Kara et al., 2005) • Top management **support** necessary; bottom-up or top-down integration (International Standard, 2002) • Initial and sustained **motivation**; "environmental **champion**s" and **engagemen**t of senior management (Bhamra, 2004) • Need for corporate sponsor and support of middle and upper management. **Celebrate** successes; learn from the **pilot** and apply in other projects. (Handfield et al., 2001) • **Competence** acquisition, change of mind necessary. Evolution of the company **culture** and interaction with stakeholders (Stevels, 2001) • Identification of the organisational change field, and consistent management behaviour. Key implementation factor: **goal setting, knowledge** development, adequate **resource**s, anchoring at all levels, and focus on **individuals**. Action learning for knowledge and skills building**. Commitment** to desired change must be created to make sure changes are accepted and durable. (Ritzén, 2000) • Conceptual ARPI framework (Analyse, Report, Prioritize, Improve) aims to break some common **organisational barriers**. Environmental **Champions** have **training** and awareness-raising roles (Simon et al., 2000)

methods, and tools (Vladimirova, 2012). If sustainability perspectives call for such a strategic transformative change, several dimensions have to fully address the complexities of such evolution, including content, context, and process. Vladimirova (2012) proposed three models to address the content (What), such as the second-order change from Levy, (1986) and Mintzberg's change cube of 1998. More recently, the business transformation model (Bititci, 2007) comprehends eight necessary business components: value streams, strategy, organisation, people, processes, systems and resources, leadership and performance measurement.

From this overview, three main implications can be proposed. Firstly, even though some convergence in general principles can be seen (transformative process, need of a systemic/multilevel approach involving organisational and individual dimensions), there is still a lack of consensus on how to plan and to implement this change process at a firm level for sustainability integration. Secondly, the behavioural dimension (e.g. expectations, intuition and judgment, individual decision-making processes, biases, power conflicts) has scarcely been studied for ecodesign integration (Szeler and Melberg, 2014), which was confirmed by the content analysis presented in section 3.2. Thirdly, there is still a lack of prescriptive methods applicable to organisations, which could guide the introduction of sustainability concerns.

Looking at the individual dimension, the behavioural change theory can complement organisational change approaches facing organisations. The Transtheoretical Model (Prochaska and Di Clemente, 2009) was proposed to assess and to improve the readiness of an individual to act on a new healthier behaviour. More recently, Prochaska et al. (2001) explored this model to fill the gap of the underdeveloped change theory, research, and practice for organisations. Leaders could apply the stages-of-change dimension approach from the Transtheoretical Model to reduce resistance, increase participation, reduce dropout, and increase change progress among employees (Prochaska et al., 2001).

Recent works by psychological experts have highlighted opportunities of using the behavioural theory for policy-making to encourage lifestyle changes considering sustainability requirements. A new approach named "green nudges" emerged.

Nudging refers to new types of incentive strategies, capable of leading individuals to make choices in the collective interest, without being seen as prescriptive or guilt-inducing (Oullier and Sauneron, 2011). No previous study has been found using nudging techniques to influence professional attitudes and choices in the direction of sustainable innovation. An approach using behavioural knowledge, including green nudges, could be an original route towards encouraging ecodesign integration at individual

level.

An initial original experiment of green nudging in a private company context was conducted in 2013 in cooperation with the Technical University of Denmark (Brones et al., 2014). However, this approach may be necessary to make change strategies more effective in complex businesses and in human organisational situations, in which management styles evolve and rely on more autonomous individuals and teams. The study concluded that further research and application of sustainable changes would benefit from considering individuals' engagement, including behavioural aspects, interaction with project teams and higher-level business organisations.

Acknowledging the challenges identified for positively applying change management strategies to promote sustainable practices at firm levels, recent social theories coming from wider sustainability studies can help fill these gaps, as proposed in the next section.

3.4. Transition management, a co-evolutionary approach for sustainability challenges

The concepts of transitions have initially been developed for large-scale socio-technical systems such as energy supply, transport, etc., motivated by public policies toward sustainability in Europe. As Geels (2005) stated, Transition research is developed in co-evolutionary approaches and highlights multi-dimensional interactions between industry, technology, markets, policy, culture and civil society. A comprehensive review on transition studies showed this development within the last fifteen years, with a new field of "sustainability transitions" represented by up to 100 scientific papers per year, and Transition Management (TM) as one of the main strands (Markard et al., 2012).

Transition involves far-reaching changes along different targets: technological, material, organisational, institutional, political, economic, and socio-cultural (Markard et al., 2012). Generally, Transition scholars emphasise that transitions are long-term and complex processes (often lasting several decades). 'Transition' is often used interchangeably with the term 'systems innovation' (Kemp and Rotmans, 2005). In particular, according to Loorbach (2007), Transition Management is a framework to steer future change. TM is based on a different process-oriented driving that attempts to mediate uncertainty and complexity with management intervention. Currently, TM is broadly applied to stimulate sustainability transitions in the scale of regions, cities and communities as well as to initiate transformations in socio-technological systems (Rotmans and Loorbach, 2009; Loorbach, 2010).

The Dutch TM concept was rooted in the complex systems theory and in recent social models and originated descriptive and prescriptive operational principles. TM was designed to deal with key problems observed in sustainability transitions (complexity and distributed control; short/long term; danger of lock-in; political myopia) in an integrated way. TM is based on complementary elements: 1) development of long-term sustainability visions and overarching joint strategies, 2) organisation and mobilisation of a multi-actor network, execution of projects/experiments, and finally 3) monitoring and evaluating as inputs to the collective learning process (Kemp et al., 2007).

Few pioneering companies have reported moving beyond traditional Corporate Social Responsibility to transform their value chains and markets along with their internal organisation. This systemic perspective on transformative business strategies has so far lacked in the literature (Loorbach and Wijsman, 2013). It is proposed here as a useful and original source toward a more effective ecodesign integration.

3.5. Towards an ecodesign transition framework

The intended synthesis of different knowledge areas is represented in Fig. 3, with the need to determine how TM approaches could address ecodesign integration challenges. A deeper understanding of sustainability transition gave rise to TM as a governance approach including a framework for experimental implementation. TM is based on a central multi-level concept that describes the dynamics of a transition as the interactions between strategic, tactical and operational levels. One of the claimed advantages of TM is the possibility to bridge the gap between top-down planning and bottom-up incrementalism, using new types of interaction and cycles of action and learning, with a deeper stakeholder management (Loorbach and Wijsman, 2013).

Interestingly, the principles of TM present high convergences with the ecodesign integration model previously elaborated (Brones and Carvalho, 2015), based on a synthesis of the ecodesign literature and previous field experiences, as represented in Fig. 4.

Thus, both models share the multi-level principle, the same three levels definitions (strategic, tactical and operational) applicable to a company context, and the complementarities of top-down and bottom-up transformation dynamics. Another strong similarity is that both approaches were developed by action research.

Hence, building on such coherent and synergies between TM principles and the conclusions from previous studies on ecodesign integration, a framework was progressively elaborated, complementing and refining previous propositions (Brones and Carvalho, 2015). This proposition could help fill the gaps found on earlier attempts to bring change management notions to the challenges of ecodesign implementation, and could be applicable to organisations interested in promoting ecodesign implementation, oriented on the soft side (organisational and behavioural).

Table 4 proposes an adaptation of the TM approaches applied to the context of product development challenges in a company background. TM at Strategic, Tactical and Operational levels (left column), translates into general principles and activities and needed capabilities described in the three central columns (Loorbach, 2007). These recommendations were converted into a series of principles applicable to the more specific purpose of introducing environmental concerns into product innovation related activities at firm level, as summarised in the right column. These guidelines were formulated in order to help a company build its own pathway toward more sustainable product innovations. The main topics have been labelled through key constructs, identified from the main recommendations of previous literature (Table 3), combined with TM principles and recommendations, and reorganised by the affinity diagramming process, in accordance with the defined systemic structure. The five key constructs are: Planet at the strategic level; Public and Program at the tactical level; and Pilot and People at the operational level.

Thus, this set of principles were developed within the whole action research to compose a full "ecodesign transition framework" (ETF), to complement previous findings and propositions that addressed the technical aspects of ecodesign integration. Besides summarizing the key findings from multistep literature reviews presented in the previous sections, this proposition of TM principles was also applied to the company field study, within the empiric part of the action research undertakings, as summarised in the next section.

4. Action research results and analysis

During the initial planning of the applied research programme, the development and implementation of more structured

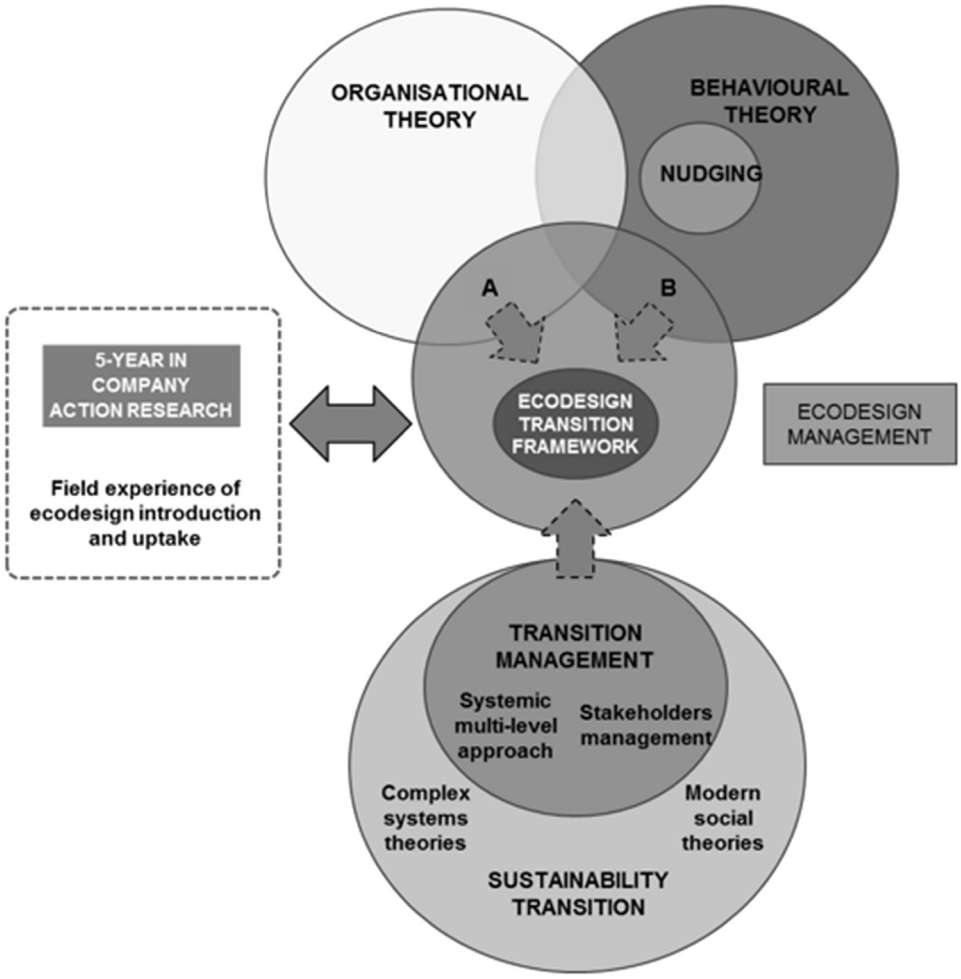
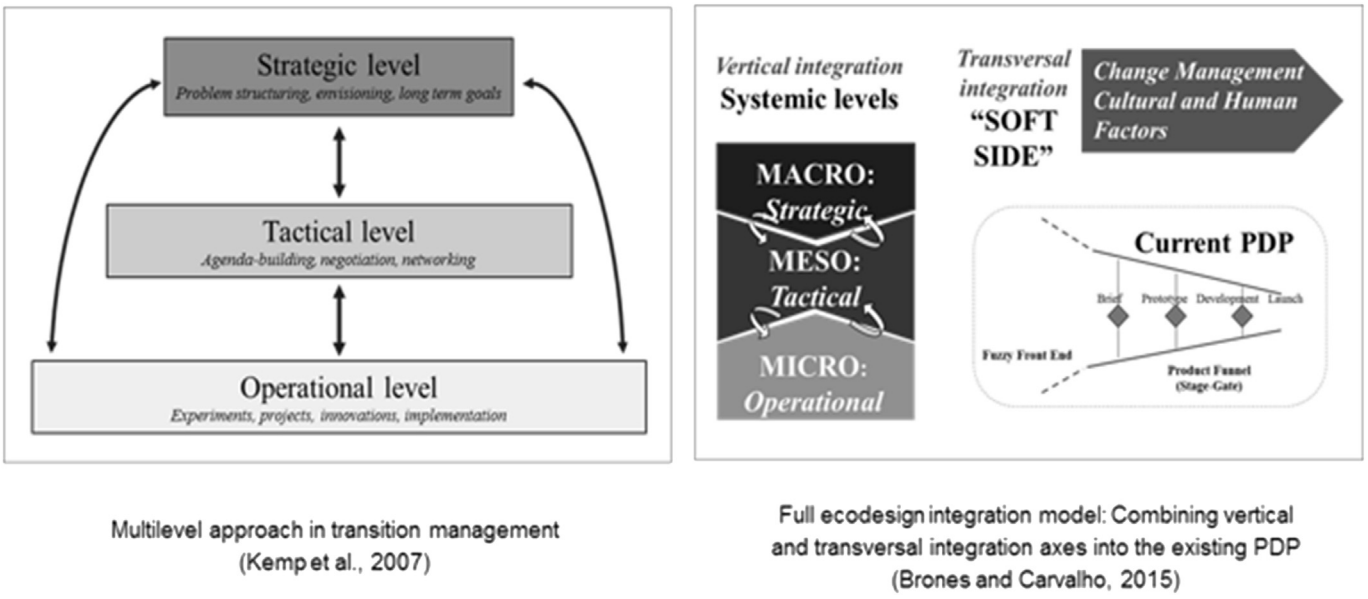


Fig. 3. Joining several change management approaches for ecodesign integration. A, B: "soft side of Ecodesign"; A: sociological - organisational approaches; B: psychological approaches.



Multilevel approach in transition management (Kemp et al., 2007)

Full ecodesign integration model: Combining vertical and transversal integration axes into the existing PDP (Brones and Carvalho, 2015)

Fig. 4. Systemic multi-level approaches from transition management and ecodesign integration.

Table 4
Transition Management Principles adapted to ecodesign integration.

Level	TM principles	TM activities & capabilities	Pathway: Applying transition principles to ecodesign integration	
Strategic Defining corporate and long term objectives of innovation and environmental sustainability, based on life cycle thinking principles	Problem structuring, envisioning, long term goals	System thinking Envisioning Creativity Communication and network skills	Planet	• Define or update the long term ambition of the organisation in environmental sustainability • Align product innovation strategy with the environmental ambition • Monitor the long and midterm plan, and maintain coherence between corporate vision and business processes
Tactical Deploying and piloting the environmental strategy in the innovation processes and instruments	Translating, agenda-building, networking	Negotiation Coalition building Communication and consensus building	Public	• Engage/influence the different groups involved in the deployment of environmental goals and procedures (middle management)
			Programme	• Formalise a plan for progressing toward a higher integration of environmental sustainability within Product innovation processes • Monitor and evaluate results, progresses and gap.
Operational Applying ecodesign principles to all related activities for decision making and product performance	Experiments, implementation, mobilizing actors	Learning and communication Project Management	Pilot	• Adapt and experiment ecodesign tools and practices to company culture in pilot projects
			People	• Engage the different groups involved in product development to understand and to apply ecodesign principles and tools (internally and externally/supply chain and innovation partners) • Capacity building and associated monitoring

ecodesign practices within the company were initially perceived as essentially technical objectives and tasks. However, during the programme execution, the diffusion challenges rapidly came out as key challenges for the success of the initiative. Corroborating the statements from the promoters of the soft side of ecodesign, as indicated in the literature and as confirmed through several

Table 5
Ecodesign Transition Management principles applied to the company field study.

Level	Key themes	Main ecodesign transition initiatives conducted in-company	
		Cycle 1 (2011–12)	Cycle 2 (2013–15)
Strategic Problem structuring, envisioning, long term goals	Planet	• support of R&D and directors as sponsors of ecodesign initiative. • Alignment with sustainability strategy	• Ecodesign progressively recognised and adopted in the sustainability Vision and strategic plans. • plan elaborated with high level management to better articulate and to deploy corporate goals with new products portfolio within business units.
Tactical Agenda-building, negotiation, networking	Public		• Ecodesign diffusion challenges considered with Development Managers and Innovation directors and innovation top management aiming at positively influencing Development and Marketing users. • Collaboration with the group in charge of PDP management to incorporate ecodesign rules in PDP with macro guidelines.
	Program	• Formal ecodesign program initiated with initial Maturity assessments and intermediate reviews, with a technical team and budget. • Initial focus on tools, customisation • Collaboration with external experts.	• Formal Ecodesign continued program. • Focus on capacity building, dissemination and engagement. • Maturity assessments and final review planned in the late 2015
Operational Experiments, implementation, mobilizing actors	Pilot	• 3 new tools experimented in 2 product development projects. • Collaboration and training in collaboration with an external Design agency	• Ecodesign tools and principles applied to 6 other Development projects, with formal follow-up and support by the ecodesign team. • Ecobenchmarking tool developed in 2015 and applied to Development project as a pilot. • Collaboration and training of external Design agencies partners.
	People	• Interviews and workshops to understand expectations and barriers from Developers and Marketing • Communication activities: ecodesign exhibition (300 + visitors), training courses, lectures with specialists. • Marketing audience seen as more complex to engage.	• Gatekeepers training, focusing on motivation (but with limited results). • Emphasis on diffusion activities: e-learning material and course; networking; mini exhibition of tendencies for ecodesign. • Nudging workshops and experiment conducted in 2013.

exchanges with specialists from Brazilian and European universities, the change management dimension called for greater attention than initially expected.

During the five years of the programme, resources from previous experiences reported in the literature as well as more theoretical principles were used to promote the adoption of ecodesign, bringing a return on experiencing such principles. The Transition Management approach and format presented in the previous section appeared to be suitable to structure and to report the efforts, as shown in Table 5, which recapitulates the main ecodesign integration initiatives, conducted in the company within the two cycles of the implementation program.

Cycle one was more focused on tool creation, to complement the existing quantitative environmental calculator used since 2010, with an expected progressive and voluntary adoption of the new tools and practice based on positive results. The options were chosen considering an early phase of the analysis of the current practices and discussions with specialists, particularly the Ecodesign Maturity assessment conducted in 2011 (Pigosso et al., 2013), which formalised the strengths and points of improvement of the situation at the beginning of the initiative.

Particularly, the need for a broader understanding of basic concepts and key practices in ecodesign and sustainability was identified as critical for motivating the change. To fill this need, a qualitative benchmarking study was conducted to inspire the NPD teams with ecodesign examples and explanations. The results were successfully diffused internally through an ecodesign week and exhibition, with over 300 visitors.

After this initiative, a creative ecodesign workshop based on design thinking approach for training and practicing ecodesign in multifunctional teams of NPD projects was developed, and applied for 9 different product development projects. More than 70 people participating in the innovation process were involved and trained.

The ecodesign tools and practices promoted the reduction of environmental impacts in simple new products development (such as packaging mass reduction, or improvement of packaging recyclability by a better choice of materials, and easier separability), and the proposal of more innovative products concepts, which could bring significant sustainability improvements (i.e.: New products form, delivering the product functions in a new way; for example, a solid format instead of liquid could strongly reduce the amount of waste and associated impacts).

Also, the choice of a more "bottom-up" diffusion approach was dictated by the recommendations of the project sponsors from the R&D management besides considering the culture of the company and management styles. During this first cycle, no activities were performed in the "Public" dimension, which can be considered a weakness, *a posteriori*.

After an intermediate evaluation of the results, conducted at the end of cycle 1, cycle 2 was more focused on the application and diffusion of the tools developed during cycle 1, trying to disseminate the pilot initiatives more effectively. This explains why more diverse "soft" initiatives were conducted, along with the fact that the concept of TM for ecodesign gained consistency during this period. The right column referring to cycle 2 in Table 5 shows the broad range of initiatives conducted in order to strongly incorporate advanced ecodesign, purposefully covering the three levels and different actors involved in the product innovation activities.

Also, the nudging experiment helped the leading team and the whole organisation be more aware of the limited intake of ecodesign after cycle 1. For instance, interviews conducted with a sample of 26 people from Marketing and Product Development showed a very high declared intention to practice ecodesign (80% strongly agreed or agreed) but at the same time many of them showed a low awareness of the technical initiative and tools. Thus, they may possibly only have declared an opportunistic adhesion, as can be interpreted from some quotes: "*I intend to practice ecodesign, but cannot really tell as I do not know how it will affect my work*"; "*It is very easy for marketing people to agree with the intention to practice ecodesign and use the tools as it won't affect our work*".

Then, different activities were planned and carried out for further motivating, promoting collective learning, knowledge management and engagement of key internal stakeholders in accordance with the TM principles of the ETF.

Hence, the integration plan included several channels to reach and to engage the target marketing and product development groups, involving intermediary management and prioritising direct contacts and participative flexible interactions, which must be compatible with each group priorities and busy agendas. Different media were used, such as e-learning, diffusion of video material, face to face and group meetings.

A Gatekeepers training was experienced for disseminating ecodesign through participative exercises as non-compulsory activity aligned with company culture, but had little effect due to the lack of engagement of potential users and management.

Then, a short electronic ecodesign training course was developed, in order to promote a wider dissemination and awareness rising to different audiences involved in the innovation processes, from different functions, as suggested by the R&D director. This course was created and released with the support of the Human Resources department, as an important actor for such wide initiative in a large company.

Along cycle 2, regular meetings were held with management at different level (NPD managers, but also the higher management from Business, Innovation and Corporate Sustainability). The advances and observed challenges were reported and discussed, and a greater support to the diffusion activities was requested. Also, the necessity for a stronger coherence between strategic commitment, tactical activities and decisions, and the operational reality in individual projects were raised and discussed.

At the end of the second cycle, a balance of the programme was conducted which showed a significant progress of maturity in terms of integrating environmental concerns in different aspects of the innovation processes and activities of the company. This balance was shared with the representatives of the innovation and sustainability teams at different hierarchical levels, showing the progresses and the points for future improvements, as discussed below.

5. Discussion

This exploratory research has led to combining TM principles with a systemic ecodesign integration model to elaborate a promising "ecodesign transition framework" (ETF). The approach was not reported in previous literature, which was confirmed by a search in the Scopus database, where no article was found combining TM and ecodesign or synonymous expressions. This proposition is seen as a new synthesis of diverse sources from the engineering literature and social sciences, building on similarities and complementarities.

Adapted TM principles are expected to allow analysing and influencing the evolution of innovation practices considering sustainability requirements in a more effective way than former change management attempts, as observed in the review of the literature and published models. In fact, the TM approach was cited in a recent review on sustainable innovation, but it was considered unsuitable to a company context (Verhulst, 2012). Based on a new and deeper exploration into the field of TM, which has recently extended from the initial application on larger societal systems (such as cities or regions), a different conclusion can be derived,

that is, TM principles can also be applied at firm level. TM provides a new management approach, with a framework for 'guided evolution', seeking to balance emerging changes, bottom-up innovation, guiding visions and collective agenda-building processes, which can address company challenges (Loorbach and Wijsman, 2013). Also, TM presents remarkable convergence with a previous company-oriented systemic synthesis on ecodesign best practices and principles.

Moreover, TM recommendations can be related to broader business management tendencies. Groysberg and Slind (2012) concluded a recent research project focused on the state of organisational communication in the 21st century, in which the command-and-control approach to management is no longer viable and lateral and bottom-up communication have become as important as the top-down one. This view strongly echoes a trend that emerged in the 1990s, with the 5th Discipline based on systems thinking and organisational learning. Senge and Sterman (1992) identified the development of new modes of organisation, more flexible and less hierarchical and authoritarian, giving increasing space to individual decision-making and innovation. Managers were advised to become 'systems thinkers' as well as better learners, forming collaborative action research partnerships to develop new tools to accelerate learning. Applying those tools embedded in systems thinking to real organisations would convert companies into learning organisations (Senge and Sterman, 1992).

The parallel field observations inside the company also influenced the emergence of the ecodesign transition framework. For example, a potential effective concept that arose from the nudging experiment and behavioural background was to look at the company organisation from a different perspective, considering each target group (marketing leaders, product development, internal and external designers groups etc.) with the following question: through whom and how could this group be positively influenced to adopt new ecodesign practices? Thus the need to combine bottom-up and top-down integration became more obvious; the most adapted approach was to identify influencers, to try and to involve them in reaching the main final users (Product Developers, Marketing Managers and Designers).

Also, along cycle 2 implementation phase, many of the decisions expected to be part of a classical product ecodesign approach were widely discussed at the portfolio level within the debates with Innovation and Sustainability Managers on how to promote more sustainable practices and accelerate reduction of environmental impacts (choice of more eco-friendly material, refill options, etc. for future projects). This tendency reinforced the perception that the intermediate tactical level considered in the ETF was quite relevant, although very few studies have approached this side of ecodesign integration (Brones and Carvalho, 2015).

Interestingly, the set of change management approaches in the ETF, emerging from the TM principles and field experience, may contribute to address the most important obstacles reflecting the social-psychological obstacles identified by Boks (2006): The gap between proponents and executors, organisational complexities, and unwillingness to cooperate. As Ehrenfeld (2008) argued, the sustainability challenge for a business is to adopt a new set of values and beliefs, facing the firms' inherent conservative cultural system, which may represent one of the main resistances to change.

However, it is worth noting that after almost completing the second cycle of the initiative in the company, ecodesign integration is still seen as a complex, challenging and slow evolution even in a quite favourable context, in which sustainability issues are strongly recognised within the company strategy. Hence, even if the observations reported from the company experience are consistent with the main success factors and obstacles identified by Boks (2006), the integration was still a progressive evolution, presumably limited by second order barriers, associated with classical change challenges, such as prioritisation issues, individual and collective interests and concerns, or "organisational entropy".

Nonetheless, the company maturity in ecodesign seems to be consistently evolving, as part of a series of activities to consolidate its leading role in the Sustainability arena, involving corporate initiatives and product innovation. This engagement characterises what Loorbach and Wijsman (2013) call "frontrunner businesses", which explore such transition experience, and thus could take a favourable position in sustainable markets and develop a competitive advantage.

At the same time, from a more global perspective, this scenario could be part of the answer to the need for a 'triangle of change', as argued by Tukker et al. (2008a), in which businesses, consumers and governmental policies perform their complementary roles. Such systemic transition in society would mean a discontinuity in production and consumption patterns, which is a central challenge for Sustainable Operations research.

6. Final considerations

This study expands the boundaries of research in the ecodesign field by integrating the emerging Transition Management approach designed for sustainability issues. We developed an Ecodesign Transition Framework and explored it through an in-depth action-research. Hence, the main contribution of the research covered in this article, combining multistep reviews, action research and learning, is a novel ecodesign transition approach and framework for managing the soft side of ecodesign integration.

The construction and application of an ETF contributes to the academic research that has started to examine the need for a more structured change management approach applicable to ecodesign, lacking in previous publications. This framework highlights the importance of five key constructs (Planet, Public, Program, Pilot, People) proposed to compose a Transition Pathway in a systemic perspective including the three essential levels (Strategic, Tactical and Operational), synergising bottom-up innovation and top-down planning.

In the new context of businesses facing Sustainability challenges, in which management practices nowadays give more room to individual and team autonomy versus directive processes, the application of such TM principles for ecodesign integration could allow fostering more effectively sustainable changes, considering individuals' engagement, including behavioural aspects, interaction with project teams and higher level business organisations in a multi-level approach.

Thus, the ETF is proposed as a tool to improve the global integration of ecodesign in product innovation processes of companies, in a structured and coherent process, taking into account the lessons from this research. The principles of the ETF intend to facilitate the organisation of "soft" integration activities, filling a gap found in previous ecodesign literature.

This research, bringing knowledge from social sciences, has tried to consider the real complexity of businesses as human organisations, and recognised the importance to be given to "soft" issues and the probable need to use "softer" change management approaches. The ecodesign transition approach appeared as a useful instrument to organise, to deploy and to monitor the soft aspects of ecodesign integration, both organisational and behavioural. It is important for companies to understand how transition cycles, as experienced in the AR company context, can be translated into flexible and polyvalent planning and application principles. A particularly interesting result from our research is that the application of the ETF could be adapted to diverse specific organisational configurations, in different companies, sectors and countries,

considering cultural specificities. For example, the dosage of top-down and bottom-up integration efforts should definitely be chosen according to each company context.

Such adaptation will be necessary to overcome the limitations of this research, based on qualitative exploration and in-company observations. Noticeably, this study is also limited by a single company context, acknowledging that it is the condition to access a business organisation from inside and to have the possibility to really experiment new solutions in a longitudinal perspective. There are several potential extensions to this research; while our study identifies key constructs in the ETF, it will be helpful to better understand the effects of diverse specific organisational contexts that will certainly modulate how such observations and strategies may be applied.

On-going research will consolidate, formalise and operationalize the diverse aspects of ecodesign integration, both hard and soft, into a complete and coherent "ecodesign transition framework" in order to further contribute to more sustainability integrated product innovation processes. This participation to expand knowledge in Sustainable Operations may be a useful contribution to broader transitions in society.

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