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Expert Insights on Successful Multinational Ecodesign Projects: A Guide for Middle Managers

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Abstract

Both the conception and the implementation of ecodesign require a strong focus on change management due to the risk of failure. This study examines the pivotal role of middle managers (MM), which have been overlooked in terms of ecodesign, despite their importance to organizations. This research builds on the multiple case study method, addressing this gap in the literature by analyzing successful projects orchestrated by MMs. The findings indicate that MMs develop various actions according to the relevant phase of the project. In the initial phase, MMs tend to expand their knowledge of the benefits of ecodesign, as well as assessing their top managers' (TMs') expectations regarding ecodesign. In the planning phase, MMs encourage engagement in the planning process, while also liaising with ecodesign professionals, identifying actions and accumulating new information. During the implementing phase, MMs seek support and engagement from TMs, improving ecodesign knowledge across the organization. The limitations of this study stem from the methods and geographical focus: multiple case studies cannot be generalized, nor does the focus on Brazilian branches allow direct generalizability to other regions, although the insights can be useful for other emerging economies. However, these limitations present possible avenues for future research.

Keywords: Ecodesign; Integration; Change management; Transition; Sustainable; Sustainability

1. INTRODUCTION

Ecodesign aims to improve the necessary balance between environmental, social, technical, and economic requirements in product/service design. The latest research on eco-design focuses on evaluation, human factors, and regulations. Studies focusing on evaluation aim to support product component selection for ecodesign (Chun et al., 2018), in order to improve the quality and increase the quantity of recycled aluminum (Soo et al., 2018), to improve the production process (Galli et al., 2018; Piccinno et al., 2018), to manage the production system (Auer et al., 2017; Kiurski et al., 2017) or to support project development (Tao et al., 2018). Research into human factors investigate the perceived prevalence of selected environmental topics in product development, their relationships with employees' ecological concerns (Sihvonen and Partanen, 2018) and the role of individual sustainability competencies in eco-design building projects of small- and medium-sized enterprises (Lambrechts et al., 2019). Two of these studies seek to improve EU Ecodesign regulations (Hinchliffe and Akkerman, 2017) and to strengthen the focus on resource efficiency in the European Ecodesign Directive (Bundgaard et al., 2017).

Furthermore, various frameworks and tools have been developed to support the conception and implementation of ecodesign projects. Some of these tools focus on knowledge improvement, generating better solutions and mitigating resistance (Brones et al., 2017; Le Pochat et al., 2007). The advancement of knowledge is highly desirable, as a qualified, engaged professional is in a good position to assess the company's situation and ensure that a project meets the company's objectives (Lizarralde and Tyl, 2018; Paula Pinheiro et al., 2018; Satyro et al., 2017). Other frameworks and tools support managers and teams in terms of change management. These frameworks assist the evaluation of risks and opportunities (Oliveira Neto et al., 2018; Rodrigues et al., 2017; Rousseaux et al., 2017) in order to mitigate risks and produce results (França et al., 2017; Prendeville et al., 2017), improve product design (Brones and Monteiro De Carvalho, 2015; Lizarralde and Tyl, 2018) and focus attention on relationships with external stakeholders (Dobes, 2016; dos Santos et al., 2019; Schöggel et al., 2017). Finally, top managers' (TM) engagement in such topics is prevalent in the literature (Stone, 2006).

Problems in ecodesign implementation were also identified. As ascertained, ecodesign tools for the early design stages are lacking (Lamé et al., 2017). Some of these problems could be solved by improving change management. According to the literature, change management constitutes a critical success factor for the advancement of strategic sustainability initiatives (Sroufe, 2017). Well-

managed change can help to enhance the perceived environmental performance of manufacturing establishments (Ronnenberg et al., 2011) or to influence levels of trust and trustworthiness (Manu et al., 2015). To successfully manage change, managers should analyze critical factors based on a structured methodological process (Al-Haddad and Kotnour, 2015). Three frameworks have been proposed to support change management in ecodesign. The first framework focuses on the outlined strategy and goals for innovation and environmental sustainability, the formal incorporation of environmental requirements into the product development process and portfolio management. It also focuses on the implementation of customized ecodesign tools and the integration of environmental aspects into project management and looks at cultural and human factors (Brones and Monteiro De Carvalho, 2015). The second framework focuses on levels of design and innovation within companies (Gaziulusoy and Brezet, 2015), while the third proposes an “ecodesign transition framework” by considering both top-down planning and bottom-up innovation (Brones et al., 2017).

However, the literature indicates that not all changes planned will be successfully implemented, largely due to resistance either from managers (Cherrier et al., 2012; Crawford and Nahmias, 2010) or team members (Amarantou et al., 2018; Michel et al., 2013; Smollan, 2013). According to some authors, such resistance can be mitigated if top managers (TM) reinforce and support middle-managers (MM) (Holmemo and Ingvaldsen, 2016; Sroufe, 2017). MMs also have an essential role to play in resistance mitigation. This lower level of management includes the company’s internal leaders (IL). To influence the resistance of lower-level employees, the MMs should improve their relationships with their subordinates (Amarantou et al., 2018; Thakur and Srivastava, 2018). Managers at all levels should take note of the challenges identified in change management. These challenges have been divided into five areas: strategy, tools, collaboration, management, and knowledge (Dekoninck et al., 2016).

Despite the value of existing research, companies still have difficulty in the practical and effective implementation and use of ecodesign (Rossi et al., 2016). In this context, this study claims that MMs play a pivotal role, as they link different organizational levels and possibly different teams and functions. Accordingly, this multiple case study investigates MMs’ role in the change management of ecodesign projects, in order to further our knowledge of ecodesign implementation. Focusing on this managerial level we consider MMs’ access to both TMs and ILs, a position which can help promote change in both hierarchical levels. The research question is as follows:

What should MMs know about change management in order to support the conception and implementation of ecodesign projects?

The unique findings of this work contribute to the literature by indicating that MMs' actions aim to engage TMs, ILs, and other MMs in ecodesign projects, as well improving professionals' knowledge of ecodesign, and fostering an internal culture that favors change (Brones and Monteiro De Carvalho, 2015; Brones et al., 2017). These actions seem to fall into three phases: initial, planning, and implementation. In the initial phase, MMs expand their knowledge of the benefits generated by ecodesign in other companies, as well as contributing to the knowledge of ILs and other MMs. Only after improving their knowledge do MMs try to engage TMs. To do this, they present the possible gains to TMs (W.-J. Long et al., 2018). Once the TMs are on board, MMs move to the planning phase. In this phase, they encourage ILs' and other MMs' engagement in the planning of the ecodesign project, thus lowering their resistance to the changes required, as well as refining the planned actions (Sroufe, 2017). They also try to improve ILs' and other MMs' knowledge when planning ecodesign changes. In the implementation phase, MMs ask TMs to approve ecodesign actions and gains, including actions to mitigate the resistance of professionals who may feel negatively affected by the changes (Vos and Rupert, 2018), where this is possible or worthwhile. Beyond this, MMs try to mitigate ILs' and other MMs' rejection of the project by acting as 'ecodesign instructors', and encouraging professionals to provide training. These vital findings contribute to the literature by focusing on MMs, as the literature to date tends to focus on either top management or employee engagement (Ammenberg and Sundin, 2005; Brones et al., 2017; Perron et al., 2006; Sroufe, 2017).

2. LITERATURE REVIEW

Our literature review examines the potential barriers to successful change management in organizations, the motivations observed in change management, and the models/frameworks proposed for promoting positive changes towards ecodesign/sustainability. The findings of this literature review are then used to define an initial research framework, designed to support the fieldwork conducted in this research.

Hindering change

The literature examines several barriers that may hinder organizational change, including change towards sustainability. For this study, these barriers have been organized into the categories of managerial resistance, team resistance and other barriers. Details of these barriers are presented below.

First, managers may constitute a barrier to the changes which they should in fact endorse (Cherrier et al., 2012). They may disregard or reject the implementation of corporate environmentalism within their organization due to power struggles (Knol et al., 2014) or competition between the Project/Program Manager and Change Managers for the managerial role in organizational change projects (Crawford and Nahmias, 2010). Such managerial competition is counterproductive and constitutes a barrier to change (Hornstein, 2015).

Team members may also reject change. Employees' resistance to change may be influenced by their personality traits, sense of job security, their relationship with management (Amarantou et al., 2018), organizational context or the way the change is managed (Michel et al., 2013). One study identified perceptions of organizational justice during change as being an essential contributor to the creation and erosion of trust in management (Smollan, 2013). Training can also constitute a barrier since it may not increase employees' environmental awareness of the company's environmental impact (Perron et al., 2006).

Further barriers identified in change projects which do not fit into either of the previous categories are also presented in the literature. Such barriers include resource dependencies, costs, turbulent organizational environments and knowledge integration (Knol et al., 2014). Barriers to the transition from traditional business models to business models for sustainability were also identified. These barriers include external events and principal-agent issues, as well as a lack of support from broader actors and systems. (T. B. Long et al., 2018). Organizations also tend not to use all available tools to promote sustainability. A study covering 17 institutions in 13 countries across four continents identified that few institutions are using toolsets in an integrated way across all dimensions of institutional practice (as is the case with the Accelerator tool). Failure to use available tools hinders the integration of sustainability in all dimensions of higher education practice (Kapitulčinová et al., 2018), but stakeholders could help to leverage this change. A study in the UK retail sector showed that investors have started encouraging companies to report on sustainability issues, however, these same investors do not always consider the information when it is reported (Sullivan et al., 2012).

Influencing change

The literature presents several elements that should be observed in change management. For this study, these elements have been organized into managerial and team resistance mitigation. Opportunities to improve organizational culture, knowledge, and communication were also considered in this study, the details of which are presented below.

TMs can mitigate lower-level managers' resistance to change. To do so, TMs should include middle managers in their implementation of change processes (Frona and Moriceau, 2008) and motivate these managers (Bhamra, 2004; Handfield et al., 2001). Beyond this, TMs should support environmental specialists (Ammenberg and Sundin, 2005), provide financial resources (Donnelly et al., 2006), provide appropriate incentives (Hallstedt et al., 2010) and engage stakeholders in change management (Jørgensen et al., 2006; Sroufe, 2017). Another study indicates that TMs' actions should be taken earlier and more intensively in order to leverage lean efforts (Holmemo and Ingvaldsen, 2016).

Furthermore, managers at all levels may face fewer problems when implementing changes if they pay attention to individuals (Chrusciel, 2008; Thakur and Srivastava, 2018). According to the literature, managers should be capable of influencing strategic direction and skilled in managing the political dimensions of their projects (Box and Platts, 2005), as well as understanding how the people involved in/affected by the change may perceive the potential gains for them (Chrusciel and Field, 2006). The analysis of such gains is essential, since the agents of internal change may require an external stimulus to initiate a change in mindset; e.g., a financial or a political crisis (Saka, 2003). Beyond this understanding, managers should further analyze whether or not their subordinates fit the organization's vision, are motivated in their job, participate in the decision-making process (Amarantou et al., 2018; Tummers et al., 2015) and have an emotional connection to the change (Vos and Rupert, 2018). Managers can help to mitigate internal resistance by developing a good relationship with their subordinates (Parish et al., 2008), by adopting a participative management style in order encourage the questioning of factors that could endanger change (Pardo-del-Val et al., 2012) and by increasing the autonomy of their subordinates (Parish et al., 2008; Tummers et al., 2015). These actions may help to create high-quality teamwork, which helps to improve employees' proactivity and vitality when implementing changes (Tummers et al., 2015).

Another group of studies focuses on the mitigation of cultural barriers, since organizational culture, workgroup culture and national culture are complexly interconnected and all influence human action (vom Brocke and Sinnl, 2011). Findings have indicated that cultural improvement could reduce employees' resistance to change (Maheshwari and Vohra, 2015). Therefore, organizations which want to implement successful changes (such as the lean journey) must analyze their organizational culture (Paro and Gerolamo, 2017). Such analysis may reveal alternatives to minimizing ambivalence towards change (Moon, 2009), as well as improving communication and promoting cross-functional integration (Maheshwari and Vohra, 2015).

Considering knowledge gaps is also mandatory in change management. To address these gaps, TMs must encourage their employees to share knowledge from, and about, customers with others, as well as making use of knowledge provided by others (Salomann et al., 2005), and providing training to all team members (Maheshwari and Vohra, 2015). Lower-level managers can also help to improve internal knowledge. To do this, they should first improve their skills and knowledge to "make sense" of organizational change (Andrews et al., 2008). Beyond that, these managers should ensure that their teams understand the organization's goals (Jørgensen et al., 2004), that the designers have

the information required (Lofthouse, 2006), and that their teams have the requisite in-depth engineering and managerial knowledge of cleaner production tools (van Berkel, 2007). Despite the importance of the topic, the professional requirements for Change Managers have been subject to little research scrutiny to date (Crawford and Nahmias, 2010). The findings indicate that honing the change-management skill of "coaching" is required even for experienced managers, although the managers themselves may not feel this is necessary. (Jorritsma and Wilderom, 2012). Unlearning may also be required in order to promote change. The unlearning process may be leveraged by understanding the need for change, organizational support and training, assessment of change, positive experiences and informal support, the promotion of past changes, and individuals' views, feelings and expectations (Becker, 2010).

Communication skills are considered to be far more critical for successful implementation of change than technical skills (Harison and Boonstra, 2009). Effective communication ensures stakeholder participation in the change management process through teamwork and empowerment (Butt et al., 2016). The literature indicates that managers can improve the initial communication of change by aligning employees' expectations of communication with an understanding of the goals of change (Frahm and Brown, 2007) as well as by developing an integrated, shared understanding and vision of a collective future (Sroufe, 2017). The development and publication of sustainability reports is another type of communication used by some companies. Such communication drives sustainability-related change within the company, leading to changes in data and indicators, strategy, organizational change, reputation and validation, stakeholders, and reports themselves (Lozano et al., 2016). Regarding the distribution of the message of change, one study identified that change leaders can concentrate resources on a few positively or negatively influential individuals, taking advantage of existing communication networks to persuade and inform others (Kim, 2015).

Table 1 presents a summary of the barriers and alternatives to encourage generic change (i.e. not specifically associated with ecodesign).

Table 1 – Factors which hinder and encourage generic change

Code	Summary	References
Barriers to change		
Managers' resistance	Managers may resist change, in some cases due to internal power struggles.	Knol et al. (2014); and Hornstein (2015).
Teams' resistance	Team members may resist change due to personality traits, job security, or employee-manager relationships.	Amarantou et al. (2018).
Other barriers	External events, lack of support from broader actors, or non-use of the available tools.	Kapitulčinová et al. (2018); and Long et al. (2018).
Encouraging change		
TMs' actions	TMs should engage MMs and stakeholders and provide resources from the beginning to leverage change.	Holmemo and Ingvaldsen (2016); and Sroufe (2017).
Managers' actions	Managers should pay attention to individuals, influence strategic direction, analyze whether their subordinates fit with the organizational vision/are engaged, and adopt a participative management style.	Amarantou et al. (2018); Thakur and Srivastava (2018); Tummers et al. (2015); and Vos and Rupert (2018).
Cultural improvement	Mitigation of cultural barriers by promoting cross-functional integration.	Maheshwari and Vohra (2015); and Paro and Gerolamo (2017).
Knowledge improvement	Minimization of knowledge gaps requires improvement in managers' skills and knowledge.	Maheshwari and Vohra (2015).
Communication	Communication should promote teamwork and empowerment, presenting an integrated and shared understanding and vision of a collective future. Publication of sustainability reports, and focus on a few positively or negatively influential individuals is also necessary.	Butt et al. (2016; Kim (2015); Lozano et al. (2016); and Sroufe (2017).

Frameworks and tools to leverage ecodesign

The literature presents frameworks and tools that aim to promote the transition towards ecodesign. For this study, these frameworks and tools have been divided into the following categories: leveraging change management, managing ecodesign and improving technical specifications or evaluating opportunities and alternatives. These frameworks and tools are presented below.

One model, which focuses on change management, proposes a three-level systemic approach (on macro, meso and micro scales). At the “macro” level, strategy and goals for innovation and environmental sustainability are considered; at the "meso" level, there is formal incorporation of environmental requirements in the product development process and portfolio management; and the "micro" level involves implementation of customized ecodesign tools and integration of environmental aspects into project management. Beyond this, a transversal approach is also proposed, focusing on change management and the "soft side" of ecodesign, emphasizing the company's culture and human factors in a multifunctional vision (Brones and Monteiro De Carvalho, 2015). Another framework presented in the literature helps to explain how wider-scale systemic changes can be addressed in the smaller elements of socio-technical systems, specifically focusing on the design and innovation level within companies (Gaziulusoy and Brezet, 2015). An “ecodesign transition framework” is also presented, considering both top-down planning and bottom-up innovation, with new types of interaction, dynamic cycles of action and learning, along with full stakeholder management (Brones et al., 2017).

Other frameworks and tools have been developed with the aim of supporting ecodesign management, all of which are summarized in Table 2 below.

Table 2 – Frameworks and tools for ecodesign and change management

Focus of framework/tool	References
Improve knowledge	Bonou et al. (2016); Brones et al. (2017); Rossi et al. (2016).
Improve collaboration	Bonou et al. (2016); Brones and Monteiro De Carvalho (2015); Brones et al. (2017).
Engage TMs	Brones et al. (2017).
Assess company situation	Pigosso et al. (2013).
Align projects with objectives	Brones and Monteiro De Carvalho (2015); Brones et al. (2017); Paula Pinheiro et al. (2018); Prendeville et al. (2017); Satyro et al. (2017).
Evaluate opportunities and actions	Bonou et al. (2016); Dobes et al. (2017); Oliveira Neto et al. (2018); Rodrigues et al. (2017); Rousseaux et al. (2017).
Avoid risks and leverage results	França et al. (2017); Prendeville et al. (2017).
Improve design	Brones and Monteiro De Carvalho (2015); Brones et al. (2017); Lizarralde and Tyl (2018) .
Implement the circular economy	Heyes et al. (2018).
Manage change	Brones and Monteiro De Carvalho (2015); Brones et al. (2017); Gaziulusoy and Brezet (2015).
Manage the company's relationships	Dobes (2016); Küçüksayraç et al. (2015); Schöggel et al. (2017); dos Santos et al. (2019).

A further set of frameworks was developed in order to improve products, processes, and services. These frameworks focus on: supporting product/service system (PSS) customization in the early phases of the design process (Song and Sakao, 2017), minimizing the environmental impact of additive manufacturing processes (Tang et al., 2016), integration of Life Cycle Assessment (LCA) with computer-aided product development (Tao et al., 2017) and identifying the best design criteria for a specific product (Younesi and Roghanian, 2015).

The second set of studies aims to support the selection or improvement of materials. This includes: evaluating new materials and hence measuring their real benefits (Almeida et al., 2018; Borchardt et al., 2011), comparing processes and systems with and without ecosystem services, evaluating improvements and following the system performance over time (Giannetti et al., 2006; Sellitto et al., 2013). This research also evaluates the synergistic reduction effect of using urban sewage as an alternative raw material or fuel in clinker production (Liu et al., 2015), and examines feasible packaging options (Almeida et al., 2017; Gustavo et al., 2018). Frameworks and tools focusing on materials also propose the possibility of using natural fibers to replace glass fibers in the automotive industry (Alves et al., 2010), as well as supporting the designer in the selection of the most suitable carbon fiber-reinforced composite configuration (orientations, number of plies, material type) for aircraft structures (Calado et al., 2018). Furthermore, this research supports material selection for vessels (Favi et al., 2018), analyzes the use of textiles in the aircrafts' components (Moreira et al., 2015), and identifies key material efficiency considerations within the policy context (Tecchio et al., 2017).

A third group of frameworks and tools is aimed at supporting the assessment of environmental impacts. These frameworks were proposed for assessing the environmental impacts of the functional performance of cement (Sagastume Gutiérrez et al., 2017), and fiberboards made from agro-industrial residues (Freire et al., 2017). A further three studies analyzed the interaction, integration and assessment of a techno-ecological system (Martinez-Hernandez and Hernandez, 2018), product modularity (Barbosa et al., 2017; Piran et al., 2016), and future production of nano-cellulose (Piccinno et al., 2018).

A summary of these studies is presented in Table 3.

Table 3 – Other ecodesign frameworks/tools

Focus of frameworks/tools	References
Improve products, processes, or services	Song and Sakao (2017); Tang et al. (2016); Tao et al. (2017); Younesi and Roghanian (2015).
Select/improve materials	Almeida et al. (2018); Almeida et al. (2017); Calado et al. (2018); Favi et al. (2018); Moreira et al. (2015); Tecchio et al. (2017).
Assess environmental impact	Sagastume Gutiérrez et al. (2017); Freire et al. (2017); Liu et al. (2015); Piccinno et al. (2018).

Tables 1, 2, and 3 indicate the elements that may promote or hinder changes in the implementation or improvement of ecodesign. These factors will guide the research, and a summary of these elements is presented in Figure 1.

Figure 1 – Original research framework focusing on factors that can promote/hinder change.

3. METHOD

3.1 Research design

This study adopted a qualitative approach given the multifaceted and context-bound nature of the topic. According to the literature, qualitative case studies are recommended for research which aims to develop and offer detailed insights into the complexity of organizational and individual processes (Eisenhardt and Graebner, 2007; Miles and Huberman, 2004; Yin, 2009). This approach is especially appropriate for this study since MM's role is an under-researched topic. The choice of multiple case studies aims to select information-rich cases (Patton, 2002). Based on the literature review, a codification approach for analyzing qualitative text (Saldaña, 2015) and grounded theory (Corbin and Strauss, 1990) were chosen. The existing literature was codified using ATLAS TI Software, which brought to light the factors which can promote or hinder change in the implementation of ecodesign (see Tables 1, 2 and 3, as well as Figure 1). These factors were used to define the semi-structured questions used for the interviews (see Appendix 2).

3.2 Data collection

The data collection for this study commenced with a definition of the profile of the companies to be investigated. To qualify for the study, companies must have developed projects that had generated gains which are usually associated with ecodesign projects. The eligible gains are presented in the literature (AFNOR, 2013). The research team responsible for this work also determined that these companies should have between 100 and 999 employees, and their annual revenue should range from US\$ 50 million to US\$ 1 billion. These are typical specifications to define a medium sized company (Gartner Group, 2015). Companies of this size employ more than one in four American workers, and produce more than a quarter of all revenue generated by U.S. firms (Downing, 2018). Despite their economic importance, medium sized companies have been identified as a problem area in the field of environmental regulation (del Brío and Junquera, 2003; Williamson et al., 2006). According to the literature, the environmental impact of an SME is small (relative to larger corporations). However, the total environmental impact generated by a large number of medium companies is significant (Petts, 2000).

In order to identify companies that fit the criteria, the researchers visited the trade associations of chemical, electronic, automotive, and equipment industries. During these visits, they asked for a list of the associations' affiliates who had developed projects leading to desired ecodesign benefits. Once these companies had been identified, the researchers asked the industrial associations' managers to introduce them to the TMs of these companies. Fifty TMs were initially contacted; fourteen of these returned the researchers' calls, and eight agreed to participate in the study (see Table 4). All companies investigated are in the state of Sao Paulo, in Brazil.

Table 4 – Companies investigated

Company	Industry	Headquarters	Employees in Brazil	Ecodesign results
1	Chemical	Italy	930	New product formula to allow the reuse of components at the end of life cycle.
2	Electronic	UK	830	Changes in the design and manufacturing processes to save energy in fabrication.
3	Auto parts	USA	790	Changes in the design of non-critical parts to save on material.
4	Chemical	Spain	770	New product formula to allow for the reuse of components at the end of life cycle.
5	Chemical	USA	750	New product formula to allow for reuse of components at the end of life cycle.
6	Electronic	France	900	Changes in materials to extend the product life cycle.
7	Equipment	USA	650	Changes in design to allow for the use of more sustainable materials.
8	Electronic	Germany	810	Changes in materials to extend the product life cycle.

Following this, the TMs introduced the researchers to the MMs responsible for the most successful ecodesign projects in their companies (the TMs defined the success criteria by observing their companies' objectives and the ecodesign requirements). All MMs contacted agreed to participate in the research. These MMs are directly subordinate to the TMs (without an intermediary managerial level). This process allowed for the selection of knowledgeable and engaged MMs, thus enriching the findings. The eight cases selected helped to illuminate the actions generally performed by MMs, when managing the changes required by ecodesign (a profile of the MMs selected is presented in Table 5). The number of cases is in line with the suitable range indicated in the literature, which is 6 – 10 (Yin, 2009).

Table 5 – MMs interviewed

MM	Department	Time in current role	Age	Gender
1	Engineering	8 years	47	M
2	Production	9 years	46	M
3	Production	11 years	51	M
4	Innovation	15 years	49	F
5	Engineering	11 years	47	F
6	Engineering	12 years	48	M
7	Production	9 years	46	M
8	Engineering	13 years	53	M

All interviews were conducted in July 2018. A pilot study was conducted with companies one and two, in order to test the research protocol. In these initial interviews, the MMs were questioned about the research at the end of their interviews. They offered useful suggestions such as the need to 'break the ice' at the start of the meeting, as well as to identify the point at which the relevant actions had been performed. In all interviews, the collection of data involved semi-structured interviews with the MMs, as well as document analysis. The meetings were scheduled by e-mail and carried out through Skype. Each interview lasted more than 65 minutes, with the longest lasting 93 minutes. At least two researchers attended every interview, improving the quality of data collected. Since it was not possible to record the interviews, notes were taken. These notes were later transcribed to Microsoft Word for text editing. The interviews were considered finished when two conditions were met: all research protocols had been applied, and no new evidence was emerging (Corbin and Strauss, 2007). At the end of each interview, the MMs were asked for documents relating

to the topics discussed. Five managers sent at least one electronic document, such as reports or internal communications. Findings extracted from publicly available electronic documents identified on the internet were also considered, thus allowing for some triangulation between interviews and documents. Table 6 presents the documents collected.

Table 6 – Secondary Data (documents)

Source	Documents
MM2	Specifications after changes were implemented.
MM4	Suggestions provided by teams.
MM5	Suggestions provided by teams.
MM6	Improved specifications at the end of the project.
MM8	Internal and anonymous report on profit increase after the change
Companies' web pages	Specifications after changes were implemented.
Web pages of magazines or industrial associations	New deals closed by manufacturer due to added value not provided by competitors.

Following the data collection, interview reports were created, with the collected data being coded based on grounded theory. The researchers' reports were then crosschecked in a research team meeting. The crosschecked reports were also sent to the interviewees for validation. New Skype appointments were arranged to discuss the reports. Four MMs suggested minor changes in the reports about their companies. No single Skype conversation lasted less than 60 minutes in this round, with some lasting for 90 minutes. All MMs consequently asked the researchers about the findings, which in turn induced some MM to provide new information. As a result, several new and exciting points were collected during these conversations, thus helping to improve the findings.

3.3 Trustworthiness, credibility, and reliability

Experts revised the study, intending to allow for future replication (Eisenhardt, 1989). A strict set of criteria was used to ensure trustworthiness, credibility, and reliability. These criteria comprised the extent to which the company fit the research objectives, understanding, generalizability, control (Corbin and Strauss, 2007), transferability, dependability, confirmability and integrity (Corbin and Strauss, 2007; Hirschman, 1986; Wallendorf and Belk, 1989). A high level of fit was observed in the selection of the companies. The presentation of findings to the interviewees showed understanding, while generalization was seen in the selection of MMs working for companies of a similar size. Control was evident in the validation of conclusions by the participants, and transferability refers to the selection of MMs who work for companies that have developed ecodesign projects. Dependability was covered by the focus on ecodesign benefits (according to the associations and TMs), and confirmability relates to the individual analysis of each case, which was always executed 2-3 days after the interview and included all evidence related to the actions performed by each MM interviewed. Following the analysis of each case, a cross-case analysis was performed. These analyses aimed at identifying similarities and differences among the MMs interviewed, as well as the reasons for such similarities/differences. In both analyses, the findings were coded to compare and contrast them with the elements extracted from the literature. This codification was based on grounded theory (Corbin and Strauss, 1990; Strauss and Corbin, 1998). The revised documents were then presented to the interviewees. Integrity ensured anonymity and ethical standards were followed.

4. FINDINGS

The findings indicate that the MMs perform several actions to engage TMs, ILs and other MMs in ecodesign projects, as well as improving knowledge and internal culture (see Appendix 2). All these actions require personal and public communications and were developed with the aim of meeting three different objectives during the implementation of change. For this article, each objective is associated with a specific phase of the change process; namely: initial, planning and implementation. Figure 2 presents these objectives and phases.

Figure 2 – Phases of the change process and its objectives.

Details of the actions performed in each phase are presented below.

Initial phase

The cross-case analysis indicates that all successful ecodesign projects share a common element: MMs initiated these projects. According to the managers, the privileged position they occupy helps to explain why these implementations were successful, as MMs are the link between TMs and ILs (and all MMs are directly subordinated to the TMs). These managers seem to follow a pattern when seeking new ecodesign projects: first they expand their knowledge by assessing the gains generated by ecodesign projects in other organizations. Following this, they select "interesting opportunities." Instead of starting a new project immediately, they ask ILs and other MMs to perform the same checks and, later, to present their findings internally. As ascertained, opportunities to change the formula or design to allow for the reuse of components at the end of life cycle were

identified by sales or aftersales teams, in response to customers' demands or problems (or even the customers' customers' problems). Maintenance teams identified ways of saving energy after visiting non-competitors' facilities which use a similar production processes. New materials or more sustainable materials were adopted after technical professionals reanalyzed the products' requirements (in conjunction with their peers in the customers' organizations). The product life cycle was extended after analyzing the sales teams' that competitors offered better alternatives. This combination of checking and presentation seems to improve ILs' and other MMs' engagement in ecodesign projects. To quote exemplary testimonials:

"First, you should improve your knowledge on the cases that fit with your company reality or objectives" (MM2).

"To engage people, make them think that they have discovered the opportunity that you want to implement. To do it, you have to improve their knowledge" (MM 7).

The privileged position occupied by MMs also helps them to leverage the TMs' engagement in ecodesign projects. As ascertained, this engagement should occur as early as possible. To engage TMs in this early phase, the MMs first evaluated the gains that they expected to obtain from such a project. After ascertaining the TMs' expectations, the MMs then presented cases that had generated similar results in other companies. Our document analysis indicates that MMs' written communications to TMs focused on the environmental and economic gains provide by ecodesign in other companies. This sort of communication aims to gain TMs' approval of planning. To quote some testimonials:

"You should engage your TM as early as possible. (MM1)"

"To engage the TMs in the ecodesign project, you should focus on their gains expectations. (MM8)"

Planning phase

The planning phase begins only once the MMS have the TMs' seal of approval. The planning stage focuses on how to meet the requirements of the ecodesign project. Once again, the MMs try to engage ILs and other MMs before acting. In order to engage the appropriate professionals for the project, the MMs focus on "ego polishing." This action involves the MMs publicly praising those who have contributed to gains generated in the past. This sort of behavior seems to motivate ILs, as well as mitigating power games between MMs, since it makes each professional feel that the MM recognizes his/her competence. This recognition also seems to reinforce the ecodesign culture in the company and, following this process, MMs can ask for help from ILs and other MMs. For example:

"Do not plan anything before engaging the TM, the ILs, and the other MMs" (MM3).

"An ego polishing is more engaging than a cry for help to save the earth" (MM6).

The MMs interviewed are also aware of the negative behaviors that such praise may generate. According to them, professionals who feel underpraised may have lower engagement in projects. Despite being aware of this possibility, the MMs interviewed continue to praise ILs and other MMs, encouraging TMs to do the same. According to the MMs, the cost/benefit of this behavior pays off. Beyond the benefits previously listed, this praise also aims to induce professionals who feel underpraised to do their best. These quotes illustrate this behavior:

"Do not care about the ones who feel underpraised if you managed to engage the majority of ILs and the other MMs" (MM2).

"The under-praised will do their best to be publicly praised by you soon" (MM4).

After engaging ILs and other MMs, the MMs ask them to explore the details of how other companies have implemented ecodesign projects (having previously explored the relevant gains). The objective here is to improve the internal knowledge of best practice in the implementation of the changes required by ecodesign. To quote some testimonials:

"You have to improve the internal knowledge on the alternatives to increase the success chance of a change" (MM 6).

"When engaged people check the best practices, you improve the quality of the planning" (MM 4).

To improve engagement in the planning phase, MMs ask ILs and other MMs to present their findings on the requirements for the ecodesign implementation. These presentations also aim to publicly face up to the barriers which the ecodesign project may present. To encourage the identification of barriers, the MMs propose questions to the presenters. These questions aim to identify actions that could (or could not) be implemented by their companies. According to the managers interviewed, these public debates also help to improve the product development process. MMs also try to discuss barriers which have not been publicly discussed previously. This action helps to further improve planning. This sort of information gathering is done in private conversations with ILs and other MMs. The objective here is to identify whether a proposed change could negatively affect someone else in the company, or if a change may face some practical problem. Perceptions of job insecurity, organizational barriers, and technical problems are also checked. These actions are evident in the following quotes:

"When you promote a discussion, everyone leaves the meeting knowing new requirements or solutions. Moreover, this is important to ensure the project's success. (MM3).

"I have gathered the most important information in private conversations" (MM 1).

Implementation phase

The finished ecodesign project is then presented to TMs, who check and approve the required actions and expected gains. The approved actions usually include ways to mitigate the rejection of those who feel negatively affected by the changes, when it is possible or worthwhile for the company to do so. Only after engaging the TMs, will MMs tell TMs to provide the resources required for the project. After approving the project, MMs also reinforce the engagement of ILs and other MMs. To leverage their collaboration, MMs induce TMs to question ILs and other MMs about their contributions to the ecodesign project. Reinforcing this, MMs will habitually remind ILs and other MMs that TMs are concerned about their contributions. These additional reinforcements seem to mitigate power struggles among MMs and are evident in the quotes below:

“Before implementing anything, you have to get the TMs’ approval” (MM 5).

“The engagement and reinforcement of everyone else must be permanent” (MM2).

However, these actions do not always ensure everyone’s engagement in the project. Therefore, MMs try to leverage internal engagement by acting as a kind of ecodesign instructor. They also ask ILs and other MMs to help them provide training. Beyond providing knowledge, MMs use training to praise the contributions of everyone else in the project’s success. MMs, who act as instructors, also contribute to improving engagement as well as knowledge of ecodesign planning and implementation. Knowledge improvement includes the dissemination of actions and practices, the assessment of knowledge acquisition, and the promotion of unlearning. Beyond this, MMs who act as trainers seem to improve the change-management skill of "coaching," which is evident in the testimonials below:

“The engagement can be leveraged if you provide training, especially if the ILs and the other MMs also act as trainers” (MM6).

“I act as an instructor to improve everyone else’s knowledge on ecodesign planning and implementation” (MM 2).

Table 7 (below) presents the identified phases, their objectives, and what managers do during each phase to promote ecodesign.

The analysis in Table 7 systematizes the logical order followed by MMs when implementing changes through these phases. First, they try to engage TMs, ILs, and other MMs. Following this, they try to improve their knowledge and culture. To do so, they use both public and private communications. Figure 3 presents this logical sequence.

Figure 3 – Synthesis framework: Sequence of actions throughout the change process

Table 7 – What MMs do in each phase and why

Phase	Objective	What MMs do to promote eco-design
Initial	To identify the elements that can convince TMs to approve the planning of an ecodesign project.	<p>Manage the project from the beginning.</p> <p>Improve engagement, culture, and knowledge by checking, or by asking ILs and other MMs to check and present their findings on the gains generated by ecodesign in other companies.</p> <p>Improve their knowledge on TMs expectations of an ecodesign project, aiming to improve their engagement.</p> <p>Present the environmental and financial gains generated by ecodesign in other companies to TMs, aiming to get their approval for a new project.</p>
Planning	To reveal the requirements and actions needed to mitigate the barriers to the project	<p>Polish egos, with the aim of engaging ILs and other MMs (despite the potential negative impact of such actions).</p> <p>Improve knowledge and engagement by asking ILs and MMs to research planning in other companies.</p> <p>Improve their knowledge of possible problems by attending the presentation of results made by ILs and other MMs.</p> <p>Use personal communication to identify whether the changes could negatively affect someone in the company or if the change may encounter problems.</p>
Implementation	To obtain TMs' approval and to focus on the actions required to ensure the project's success	<p>Engage TMs by asking them to approve the project's focus, requirements, resources, and the mitigations to the expected barriers .</p> <p>Ask TMs to improve the engagement of ILs and other MMs.</p> <p>Improve ILs' and other MMs' knowledge and culture by acting as a trainer in ecodesign.</p> <p>Ask ILs and MMs to explore implementation in other companies.</p> <p>Focus on the improvement of gains.</p>

5. DISCUSSION

Initial phase

The findings of this research indicate that it is generally MMs who initiate successful ecodesign projects. To ensure good results, MMs tend to first improve their knowledge. This improvement was achieved by looking at ecodesign projects in other organizations, or by asking ILs to perform this research and then to present their findings internally. MMs' actions in the initial phase of a change process focus on improving internal knowledge (Salomann et al., 2005) and, where necessary, go about unlearning (Jacobs et al., 2013). This finding contributes to the literature by indicating that the models developed to encourage ecodesign implementation could induce MMs to do so (Brones and Monteiro De Carvalho, 2015; Brones et al., 2017; Pigosso et al., 2013).

This study has identified that internal ecodesign culture is improved when ILs and other MMs assess the gains generated by ecodesign projects in other organizations and present their findings internally. Such findings contribute by indicating an alternative that can be used by MMs to lower the internal resistance to change (Amarantou et al., 2018; Thakur and Srivastava, 2018) or to align ILs and teams with the organizational vision (Tummers et al., 2015). These findings are important and show that results can be achieved if those who collect information present it internally (Le Pochat et al., 2007).

Furthermore, the findings of this study contribute by systematizing the flow of actions that MMs can perform to engage TMs in ecodesign planning and implementation (Brones and Monteiro De Carvalho, 2015; Brones et al., 2017; Stone, 2006). As ascertained, MMs tend to gauge TMs' expectations regarding the gains of an ecodesign project. These expectations may include actions which reduce environmental impacts (Aoe, 2007), improve financial performance (Li et al., 2016; W.-J. Long et al., 2018; Plouffe et al., 2011), leverage partners' engagement (Nakano and Hirao, 2011) or better meet customer's expectations (Van Hemel and Cramer, 2002). After ascertaining the TMs' expectations, MMs present them with cases that have generated similar results in other companies. This research highlights the sort of information which should be communicated to ensure stakeholders' participation in the change process (Butt et al., 2016).

Planning phase

The findings show that MMs tend to engage ILs and other MMs before aligning employees' expectations of the change (Frahm and Brown, 2007) and developing an integrated and shared vision of the future (Sroufe, 2017). This study contributes to the current literature by demonstrating that focusing on the egos of ILs and other MMs involved in the project helps to engage them and ensure the project's success (Amarantou et al., 2018; Thakur and Srivastava, 2018). For this reason, MMs publicly praise those who have contributed to gains generated in the past. Alternatives to this technique could be included in models focused on ecodesign changes or implementation (Brones et al., 2017; Le Pochat et al., 2007; Pigosso et al., 2013). These findings also contribute by indicating ways in which power games with other MMs might be mitigated. As ascertained, this makes each professional feel that his/her competence is recognized (Crawford and Nahmias, 2010; Knol et al., 2014), thus helping to promote harmony within the team (Lambrechts et al., 2019). Considering that managerial competition constitutes a barrier to projects' success (Hornstein, 2015), this type of action seems to be mandatory to improve the engagement of other MMs'.

However, such public praise can also negatively influence the future engagement of professionals who feel underpraised. Despite being aware of this possibility, MMs continue to praise future team members and ask TMs to do the same publicly. This conclusion also indicates that the communication of exemplary cases helps to ensure stakeholder participation in change (Butt et al., 2016). This research shows that focused praise can be performed despite the potential negative implications for managerial engagement (Crawford and Nahmias, 2010; Hornstein, 2015; Knol et al., 2014).

Next, MMs ask ILs and other MMs to analyze the details of how similar ecodesign projects have been implemented in other companies, and ask them to present their findings internally. Through these actions MMs create a shared understanding and vision of the future (Sroufe, 2017; Tummers et al., 2015) and mitigate resistance to changes during the planning phase (Amarantou et al., 2018). This research reveals how MMs create the stimulus that initiates change (Saka, 2003) while reinforcing employees' emotional connection to said change (Vos and Rupert, 2018).

This study has identified that MMs faced lower resistance to change when they attended the meeting(s) in which ILs and other MMs presented their findings on ecodesign projects developed by other companies. This presence can, therefore, leverage the change process (Amarantou et al., 2018;

Thakur and Srivastava, 2018). The findings also indicate that their presence at these meetings helps to publicly reveal the barriers to change. At the presentations MMs pose questions to the presenters in order to identify the actions that could (or could not) be implemented by their companies. This finding contributes to the literature on the topic by indicating an action that can help MMs to identify barriers which may hinder the implementation of ecodesign changes (Pigosso et al., 2013) or the incorporation of environmental requirements into the product development process and portfolio management (Brones and Monteiro De Carvalho, 2015).

However, some barriers may not be publicly revealed. Further, these barriers may be dispersed across other areas and topics, such as: market (including regulation), finance, resources, activities, partnerships (especially public-private partnerships), ownership and responsibility and legitimacy (Kanda et al., 2016). In order to unveil these hidden barriers, the MMs tend to approach IIs and other MMs in private conversations. To promote these conversations, MMs circulate within their companies. According to the literature, "top-down," "bottom-up," and "middle-two sides" communications help to improve the integration of sustainable issues (Zhang et al., 2013). During these conversations, MMs ask their colleagues whether a proposed change may face some practical problem. These findings highlight that private conversations can help MMs to mitigate poor understanding of the problem or its possible solutions (Boks and Stevels, 2007; Nilsson et al., 2018), as well as preventing incorrect decisions from a sustainability perspective (Byggeth and Hochschorner, 2006; Deutz et al., 2013).

In these private conversations, MMs also try to identify whether a proposed change could negatively affect someone else in the company. This shows that MMs should consider team members' perceptions of job insecurity in order to leverage changes (Amarantou et al., 2018; Thakur and Srivastava, 2018). To mitigate these perceptions while simultaneously leveraging the emotional attachment of their teams to change, MMs try to explore the perception of personal gains during private conversations (Chrusciel and Field, 2006). It is therefore evident that MMs' conversations can engage/motivate their colleagues (Bhamra, 2004; Fronda and Moriceau, 2008; Handfield et al., 2001) and reveal the external stimuli required to initiate changes in a given colleague's mindset (Saka, 2003; Vos and Rupert, 2018). MMs' conversations with other MMs also helps to improve the planning phase. This important finding shows that these kind of conversations can improve relationships between MMs (Parish et al., 2008) and foster a participative management style (Pardo-del-Val et al., 2012).

Implementation phase

The findings of this research show that MMs improve TMs' engagement in the implementation phase by asking them to check and approve ecodesign actions and gains, including actions to mitigate resistance from those who may feel negatively affected by the changes. This conclusion adds to the literature as it demonstrates how MMs can simultaneously engage the top stakeholders (Jørgensen et al., 2006; Sroufe, 2017) and the lower levels of their organizations (Amarantou et al., 2018; Thakur and Srivastava, 2018) in the implementing phase. The inclusion of the TMs constitutes a required step in a model designed to improve cleaner production and pollution prevention (Stone, 2006), carry out the integration of ecodesign in SMEs (Le Pochat et al., 2007) or in an ecodesign transition framework (Brones et al., 2017). Importantly, only after engaging TMs do MMs ask them to provide the resources required for the project.

This study shows that MMs continually reinforce the engagement of ILs and other MMs, even in the implementation phase. This conclusion contributes to the literature by indicating that collaboration in models to improve sustainability or ecodesign should be permanently emphasized by MMs (Brones et al., 2017; Le Pochat et al., 2007; W.-J. Long et al., 2018). To improve collaboration and engagement, MMs encourage TMs to question ILs and other MMs about their contributions to the ecodesign project. Furthermore, MMs deepen TMs' reinforcement by reminding ILs and other MMs that the TMs have suggested contributions from them. This demonstrates the ways in which MMs try to mitigate power struggles with other MMs (Crawford and Nahmias, 2010; Hornstein, 2015; Knol et al., 2014) and how MMs try to indirectly improve their relationship with employees (Amarantou et al., 2018; Thakur and Srivastava, 2018).

However, the TMs' reinforcement alone does not seem to ensure the required engagement. Conscious of this, MMs act as instructors of ecodesign to mitigate resistance. This important finding highlights the ways in which MMs try to create a shared understanding and vision of the future (Sroufe, 2017), while increasing internal collaboration (Brones et al., 2017; Le Pochat et al., 2007; W.-J. Long et al., 2018). Cultural reinforcement is emphasized when MMs ask ILs and other MMs to help them provide training or when they use these training sessions to praise others' contributions. This reveals the strategies MMs use to leverage the internal culture (Maheshwari and Vohra, 2015).

MMs who act as trainers help to improve employees' knowledge of ecodesign. MMs, therefore, improve teams' knowledge dissemination (Salomann et al., 2005), while also assessing

teams' knowledge acquisition (Jørgensen et al., 2004; Lofthouse, 2006; van Berkel, 2007) and promoting unlearning where necessary (Becker, 2010). Furthermore, the MMs who act as trainers improve the change management skill of "coaching." These findings bring to light possible actions which improve MMs' managerial skills (Jorritsma and Wilderom, 2012), as well as suggesting that sustainability and ecodesign models could induce MMs to do so (Brones et al., 2017; Le Pochat et al., 2007; Stone, 2006).

The actions performed in the previous phases to acquire, analyze, and disseminate knowledge seem to reflect those performed by MMs in the implementation phase. However, these actions have a different focus. This conclusion contributes to the field by indicating that knowledge management in ecodesign projects may have several focuses. Each focus is associated with the demands of a specific phase and aims to develop processes not only for the implementation of ecodesign (Pigosso et al., 2013), but for the development of customized ecodesign (Brones and Monteiro De Carvalho, 2015) and the improvement of dynamic cycles of action and learning (Brones et al., 2017).

6. CONCLUSION

This study began by investigating how MMs manage the change process when developing a new ecodesign project. This topic is understudied, as most research on ecodesign focuses either on top management or employee engagement (Ammenberg and Sundin, 2005; Brones et al., 2017; Perron et al., 2006; Sroufe, 2017). Our findings indicate that MMs' actions aim to engage TMs, ILs, and other MMs in ecodesign projects, as well as improving knowledge and internal culture. The actions identified were organized into three phases: initial, planning and implementation. Our findings not only have practical and end-user-oriented implications, but also implications for ecodesign theory.

Theoretical contributions

In the initial phase, our findings make a contribution to the topic by demonstrating that it is MMs who generally initiate successful ecodesign projects. As previously ascertained, they first improved their own knowledge, as well as that of their colleagues, in terms of the gains generated by ecodesign in other companies. As highlighted in the study, internal ecodesign culture is leveraged when MMs and ILs evaluate ecodesign projects orchestrated by other organizations and present their findings internally. Once internal knowledge of ecodesign gains has been improved, MMs generally attempted to engage TMs. To do this, MMs first gauged TMs' expectations regarding the gains of an ecodesign project, and consequently presented the environmental and economic gains generated by ecodesign in other companies, thus improving the TMs' engagement in the project.

In the planning phase, this study shows that "ego polishing" – or focused praise – helps to engage ILs and other MMs in the planning of ecodesign projects. The findings also contribute by indicating that this technique aims to induce professionals to do their best. This practice seems not to promote cross-functional integration, which conflicts with the suggestions presented in the literature. Another contribution highlights that MMs can face lower resistance if they attend meetings in which ILs and other MMs present their research findings. MMs should pose questions at these meetings that help to identify actions that could be implemented by their companies. MMs should also approach ILs and other MMs in private conversations to identify other barriers which have not been presented publicly.

In the implementation phase, this study suggests that MMs can improve TMs' engagement by asking them to check and approve ecodesign actions and gains, including actions to mitigate the resistance of those who feel negatively affected by the changes. After engaging TMs, MMs generally attempted to reinforce the engagement of ILs and other MMs, by asking for TMs' help. Further, MMs can mitigate resistance to the project by acting as instructors of ecodesign, which has the added benefit of improving employees' knowledge of ecodesign planning and implementation. Finally, this study indicates that knowledge management in ecodesign projects may have several focuses, and each focus is associated with the demands of a specific phase.

Managerial implications

This study provides guidance on multinational ecodesign projects, particularly for MMs. Managers should pay careful attention on change management that is of central role as a result of the risk of failure that is associated with ecodesign projects.

The findings of this research reveal that MMs play a pivotal role on three areas: the engagement, knowledge and culture related to these projects. Each of these areas offer lessons and insights for managers:

Lesson 1: MMs can ensure the initial engagement of TMs by understanding their gains expectations. After knowing such expectations were identified, MMs should present to TMs similar gains generated by ecodesign in other companies.

Lesson 2: MMs can leverage the prospection of the gains expected by TMs by engaging other MMs and ILs. To engage these professionals, MMs can make sure appropriate praise is given to those having helped in the previous projects or in the gathering of valuable information for the current project.

Lesson 3: MMs can improve planning by asking the engaged professionals to collect information from other companies, by attending the presentation of the information collected by these professionals, by inducing everyone else to evaluate the possible application (or not) of the information collected in the company, by analyzing personal perceptions of losses that such actions could generate among the professionals, and by using personal contacts to identify possible problems or perceptions not expressed by the professionals in the meetings.

Lesson 4: MMs can engage TMs in the implementation by asking them to approve the actions and requirements planned.

Lesson 5: MMs can improve the implementation by acting as a trainer on ecodesign or by inducing TMs to ask ILs and MMs to explore the best practices for this phase in other companies.

Lesson 6: MMs can leverage other ecodesign projects by assuring that the gains expected by the TMs will be met.

Methodological implications

The study addresses a methodological shortcoming in previous literature through building on the multiple case study method on successful projects orchestrated by MMs. The role of MMs is focal in three different phases of the projects: the initial, planning and implementing phase. In the initial phase, MMs can improve organizational learning by expanding the knowledge and expectations of the benefits regarding ecodesign. In the planning phase, MMs could encourage engagement in planning and liaise with ecodesign professionals to accumulate knowledge. During the implementing phase, can enhance ecodesign knowledge across the organization with the help of TMs' support.

Limitations and future research

This study has certain limitations, which must be addressed. First, as only 12 companies were investigated a further study might include a larger number of companies. The findings of a multiple case study cannot be statistically generalized (Eisenhardt, 1991). Therefore, other research methods could be used to test the possible generalizability of these results; for example, surveys.

Additionally, this study focused exclusively on the Brazilian branches of the companies investigated. This condition also constitutes a limitation, since Brazil may present competitive reality not present in developing countries, for example (Schoenherr et al., 2012). Furthermore, the branches of the companies investigated are in only one Brazilian state. It's possible that the companies studied were committed to ecodesign from the early stages, and this commitment may have contributed to the success of the projects. Therefore, further studies should investigate companies which are not committed to ecodesign. A comparison of MMs' actions in companies which are, respectively, committed and not committed to ecodesign may further our understanding of the

topic. Finally, it is paramount to recognize that any research on sustainability may be affected by social desirability bias, which means that respondents may try to give responses which they believe will satisfy researchers' hypotheses (Roxas and Lindsay 2012). The interview method might also influence the results as respondents had to recall how the changes were identified, planned, and implemented.

Future studies could also replicate this research in other countries or investigate the questions that have emerged from the analysis presented in the discussion section. These questions were divided according to the phases identified and are presented below.

In the initial phase, it would be interesting to address the following question: How should MMs select and approach other companies, in order to improve their knowledge of ecodesign, as well as the knowledge of ILs and other MMs? How can MMs select the actions that best fit their companies? Beyond the presentation of economic and environmental gains, what else should MMs do to engage TMs? A quantitative study could also explore where the most successful ecodesign projects have started.

In the planning phase, it would be interesting to ask the following questions: Does the "ego polishing" performed by MMs help to engage ILs' and other MMs' in the planning of ecodesign projects? How could MMs improve this technique? Does this technique negatively affect the engagement of underpraised professionals? Does it induce underpraised professionals to try their best, in order to gain praise? Should MMs care about those who feel underpraised? How should MMs mitigate the negative feelings of professionals who feel underpraised? What should MMs consider when proposing questions to improve ecodesign planning? What is the best way for MMs identify and approach professionals who object to the change, but have not done so publicly?

In relation to the implementation phase, the following questions may be of relevance: What else should MMs consider doing to gain TMs' approval for projects, beyond project focus, expected gains and options to mitigate expected barriers? How can MMs induce TMs to help them to improve the engagement of ILs and other MMs? What should MMs or IL do when acting as a trainer to encourage the ecodesign implementation? What influence does acting as an instructor of ecodesign have on a project's success?

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Appendix 1: Interview guide

Table 8 – Research areas and proposed questions

Research area	Proposed questions
Hindering change	
Managers and team members may resist changes.	1. Have you faced rejection from ILs and other MMs when implementing changes?
	2. If yes, then ask: Could you provide some details about this rejection?
Other elements that may hinder progress towards ecodesign.	
Leveraging change	
TMs' actions can leverage changes.	3. How can TMs help to leverage changes toward ecodesign?
Engagement of team members in accepting change.	4. How can you engage ILs and the other MMs in the implementation of change?
Mitigation of cultural barriers to change.	5. How can culture be used to leverage change?
Use of knowledge to leverage change.	6. How can knowledge be used to leverage change?
Use of communication to leverage change.	7. How can communications be improved to leverage change?
	8. How could the project be improved?

Appendix 2: Coding of performed actions

This table codes the actions performed by MMs to engage TMs, ILs and other MMs in these projects, as well as to improve knowledge and internal culture.

First-order codes	Second-order codes	Overall codes
Managing the project from the beginning.	Preparing him/herself	Initial phase
Understanding TMs' expectations.		
Asking ILs and other MMs to identify gains generated in other companies.	Engaging others from the beginning	
Presenting gains generated in other companies to engage TMs.		
Praising ILs and other MMs to engage them in the planning.	Reinforcing engagement in planning	Planning phase
Asking ILs and MMs to research planning in other companies.		
Attending ILs' and other MMs' presentations to improve the MMs own knowledge.	Identifying problems	
Identifying whether changes could negatively affect someone in the company.		
Asking TMs to approve project, resources, and mitigations to the anticipated barriers.	Approving the plan	Implementation phase
Asking TMs to improve ILs' and other MMs' engagement.	Managing implementation	
Improving knowledge and culture by acting as a trainer or by asking ILs and other MMs to explore implementation in other companies.		
Focusing on the improvement of gains.		