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Review

A systematic literature review on firm-level proactive environmental management

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ABSTRACT

There is a broad spectrum of proactivity in environmental management practices in companies and industries, ranging from purely reactive efforts to adhere to minimum regulatory standards to innovative projects to develop new pollution preventing technologies and risk mitigation strategies. In fact, the importance of a proactive environmental management is increasingly recognized by academics, practitioners and policy makers alike. However, proactivity is still not clearly captured by current environmental management models, which often do not include it as a core element and lack practical guidelines on how to operationalize it at firm-level. In order to systematize the fragmented understanding on proactive environmental management practices applied in companies and industries, including their operationalization and determinants, we conducted a comprehensive review of 116 academic papers. Our results are presented and discussed along three main perspectives: (i) evolutionary stage models; (ii) typology models; and (iii) proactive practices. By comparing these three perspectives, we found that only the evolutionary stage models can fully capture proactive environmental management approaches in an integrative way, while the other two perspectives assume proactivity is highly specific of an organizational sector or function. The results also allow us to clarify and distinguish proactivity-related terms and concepts that are often used interchangeably, such as cleaner production, pollution prevention and eco-efficiency. Finally, we developed a synthetizing framework of the current literature on firm-level environmental proactivity that integrates proactive practices (divided into three dimensions: organizational, operational, and communicational), drivers of proactivity and evolutionary maturity stages towards increased proactivity. This framework not only consolidates the current state-of-the-art in terms of proactive environmental management practices but it can also be thought of as a starting point for further research on the topic.

1. Introduction

One of the most traditional streams of environmental management literature addresses the analysis and classification of firm-level environmental management practices (Kolk and Mauser, 2002). Berry and Rondinelli (1998) offered a summary of that early literature with a special emphasis on the concept of proactivity. According to these authors, firms were largely unprepared for environmental regulations in the 1960s and 1970s. As regulation intensity increased during the 1980s, firms tended to adopt a reactive approach to environmental management with actions and practices designed to simply match minimum mandatory performance levels. Next, during the 1990s, a number of organizations pioneered a proactive approach to environmental issues by anticipating actions and considering issues that were not yet fully regulated, and even achieving competitive advantage by doing so. Since then, best practices have been standardized and diffused, and many industries witnessed large adoption of corporate sustainability goals as a result of growing public awareness regarding environmental issues and climate change (Fiksel, 2009). Thus, it can be argued that, while environmental management has historically been relegated to a strictly legal corporate function aimed at reacting against regulatory pressures and limited to pollution control and end-of-pipe solutions (Sarkis, 1998; Angell and Klassen, 1999; Claver et al., 2007; Gavronski et al., 2012), that does not seem the adequate approach because of its inherent inflexibility and lack of associated innovativeness. Besides, a reactive approach can be financially ineffective, as it

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generates conformity costs that can be high enough to discourage firms with low investment capacity (Porter and Van Der Linde, 1995; Kautto, 2006; Sindhi and Kumar, 2012).

Appropriate environmental management encompasses the management of environmental risks, ranging from pollution control to more proactive practices of technology innovation. Therefore, environmental management enables cost mitigation and pollution reduction, through raw material management, the elimination and reduction of contaminants, the increase in operational efficiency, recycling and reuse, and self-regulation (Porter and Van Der Linde, 1995; Kautto, 2006).

Indeed, the use of environmental management tools is a consensus to mitigate impacts and to produce environmentally sustainable products, not only because it adopts operational practices, but also because it encompasses corporate governance principles that consider the environment as a decision criteria (Hossain et al., 2008; Chen and Monahan, 2010; Naime et al., 2015). This approach tends to be consistent with the company's cultural values (Maxwell et al., 1997; Sharma, 2001; Fiksel, 2009), and, according to González-Benito and González-Benito (2006), activities can be analyzed under three different perspectives: organizational, operational, and communicational.

Firm-level practices implemented under the organizational perspective characterize a change in companies' environmental policies, and they involve changes in procedures and the allocation of environmental responsibilities. The practices implemented under the operational perspective imply a change in production and operations, and they can be related to products or processes. And practices implemented under the communicational perspective transcend the company's limits and involve communicating to society the pro-environmental actions adopted. This perspective aims to establish a cordial relationship between stakeholders and the company.

Nevertheless, several intermediary strategic positions lie between the complete evolution from a reactive behavior to a proactive posture (Pondeville et al., 2013; Tatoglu et al., 2015). These positions can be assessed under the scope of evolutionary stages (Jabbour et al., 2014), or classification mechanisms (Kolk and Mauser, 2002). The theoretical and empirical models that address proactivity in the literature present neither a consensus on the number of stages in evolutionary models, nor an agreement about the dimensions considered in typology models. Yet, although all models describe the actions adopted under the three perspectives proposed by González-Benito and González-Benito (2006), a gap addressing the comprehension of how environmental management models (whether regarding evolutionary stages or typologies) can be related to the operationalization of proactive practices and their driving variables still remains unfulfilled.

This perception is justified on current research about the implementation of environmental management systems, which focus on the identification of the motivations that drive organizational practices (González-Benito and González-Benito, 2006; Aragón-Correa et al., 2008; Valentine, 2010; Pondeville et al., 2013; Ormazabal and Puga-Leal, 2016; Ormazabal et al., 2017; Kumar and Shetty, 2018), and on the assessment of the operational performance of these practices (Singh et al., 2012; Teng et al., 2014; Phan and Baird, 2015; Madsen and Ulhøi, 2016; Boiral et al., 2018). Questions addressing diffusion and characterization mechanisms of proactive management actions remain unsolved. Specifically, those that evaluate the interaction between the managerial, operational, and communicational levels (Prajogo et al., 2014). Therefore, this study's objective is to propose a conceptual framework that synthesizes previous literature about firm-level proactive environmental management practices applied in companies and industries, combining the approaches that propose evolutionary and classificatory models, and practices. Theoretically, this conceptual framework aims to associate the three perspectives of proactive practices (organizational, operational, and communicational) to proactivity maturity levels and evolutionary stages, as well as the pressure elements towards proactivity that act on each level. In addition, in terms of applicability, the framework intends to contribute to different organizations that seek to qualify their environmental management practices. To reach this objective, we conducted a systematic literature review analyzing 116 articles.

To address the theme, this article is divided into 5 sections. Initially, the methodological procedures applied in the systematic literature review are discussed in Section 2. The results of the systematic literature review that address the diffusion of practices based on the maturity level and their typology are presented in Section 3, together with the proactive practices identified in the literature and their drivers. A comparative analysis of the models and the practices is presented in Section 4, which also proposes a synthetic conceptual framework. Finally, the considerations about this study and the suggestions for future research are discussed in Section 5.

2. Method

Following the orientations proposed by Tranfield et al. (2003) and Moher et al. (2009), the methodology for the development of the systematic literature review involved five steps: (i) research definition, (ii) database selection, (iii) identification of keywords and terms, (iv) selection of compatible articles, and (v) data extraction and evaluation.

Based on the research question ("How are proactive environmental management models related to proactive practices cited in the literature?") (step i), we choose the Scopus and Web of Science databases to sample articles (step ii). The choice of databases is justified on their large use in scientific research due to the wide access to journals from several knowledge areas. Searches were limited to journal article and review contributions (that is, excluding conference papers), and we did not establish restrictions related to publication date. The systematic review was originally carried out between 2015 and 2016, and updated in 2018.

In step (iii), we initially employed a wide-search strategy using only the keyword "environmental management" in the databases, which retrieved 52.641 articles. Due to the high number of articles, we selected papers to serve as reference points for our research (Hunt and Auster, 1990; Berry and Rondinelli, 1998; González-Benito and González-Benito, 2008; Pondeville et al., 2013; Glavic and Lukman, 2007) in order to support the choice of the keywords. Next, the keyword "environmental management" was combined with "stage" and afterwards, in a second search, with "typology". These combinations are justified on environmental management models being typically classified as stages or typologies in the highly cited papers we used as initial reference points (Kolk and Mauser, 2002). Afterwards, a combination with "proactive" was necessary to filter for proactive environmental management practices. Finally, we searched for the term "corporate environmental management" alone, without combining it to the previous keywords, in order to comprehend how environmental management occurs in corporations at a managerial level. The query string was applied to articles' titles, abstracts, authors' keywords, and created keywords.

Step (iv), the selection of compatible articles, followed the information flow presented in Fig. 1. First, the titles of the entire set of 2506 articles found using the search strings in the selected databases was analyzed in order to eliminate those that were unambiguously unrelated to the research question (Filter 1). If there was any doubt about the pertinence of a paper based on its title, it was retained for Filter 2, when the papers that were retained had their abstracts analyzed. In Filter 2, the abstracts of the papers retained after Filter 1 were screened by the researchers for direct or indirect mentions to environmental management models and practices. The 189 articles that were retained after Filter 2 were subjected to the third selection filter (Filter 3). In Filter 3, the researchers conducted a deep reading of the introduction and the conclusion sections of each paper in order to retain papers whose objectives and results actually addressed our research question; if retained, the article in question would be subjected to data extraction in step (v). A total of 39 references from papers retained after

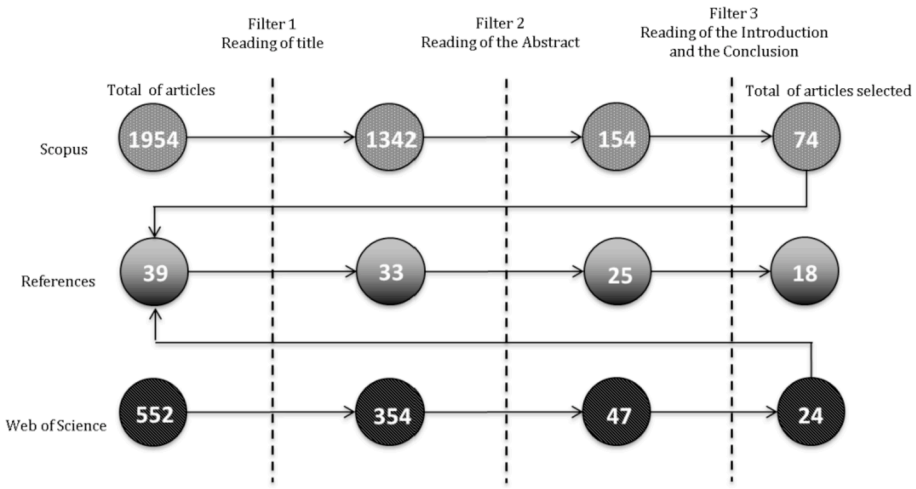

Fig. 1. Information flow for article selection.

Filter 3 were subjected to the same article screening procedure described above, which resulted in a number of additional papers selected for step (v).

Step (v), data extraction and evaluation, was aimed at synthetically documenting the main information found in the 116 articles retained after Filter 3 (Moher et al., 2009) and aggregating emerging themes in categories for synthesis following a deductive content analysis procedure based on Weber (1990). The following data was collected from each paper: journal of publication, year of publication, authorship, research objective, methodology employed in the research, industry of application, presence of an environmental management model (with the respective dimensions, steps and typologies), and the study conclusions. The deductive content analysis was employed to group similar environmental management models and practices. First, each author independently coded in a separate spreadsheet the models and practice identified during papers' evaluation. In order to improve intercoder reliability, we performed a training session with all authors in order to create a consensual definition of coding variables. Next, the spreadsheets were compared during three face-to-face meetings where all authors contributed to deductively create a common and aggregated interpretation of environmental management models and practices (Scandura and Williams, 2000).

3. Results and discussion

As described in the method, based on the analysis of the articles selected, the comparative study on environmental management was divided into three topics to improve the understanding: stage models (3.1); typology models (3.2); and proactive practices (3.3).

3.1. Evolutionary stage models

We used the dimensions proposed in the seminal works of Hunt and Auster (1990) and Roberts and Gehrke (1996) to organize the analysis of the evolutionary stage models: Environmental Management (i), Resources (ii), Practices (iii), Integration (iv), Employees' Involvement (v), and Monitoring (vi). Thus, the 14 models identified in the systematic literature review were organized according to Appendix A.

The Environmental Management (i) dimension refers to the companies' awareness to environmental issues, that is, what is their level of concern with the environment and what are the strategies used for the implementation of the environmental management practices. Resources (ii) refer to the financial value dedicated for the implementation of environmentally-related activities. Practices (iii) address the products or processes developed to implement the strategies. Integration (iv) refers to how the organizational communication occurs from a group of environment experts with other departments from the company. Employees' Involvement (v) associates the awareness and the responsibility of each employee to the environmental impacts. Finally, Monitoring (vi) involves the analysis of operations to calculate the environmental performance.

Evidently, not all the models analyzed in the systematic review thoroughly specify the dimensions. In general, models address a generic description of the development of the environmental management. Nevertheless, it is important to highlight some models that, in spite of not encompassing all the dimensions used as reference in this study, clearly identify the evolution of the environmental concern and the practices adopted with different focuses. These models show that the environmental management levels can derive from a historical concern, from the control of emission levels, from the new product development, and from pollution prevention concepts. In sum, evolutionary stage models differ regarding the number of stages and present different nomenclature. Nevertheless, they present converging ideas, that is, environmental concerns and management practices increase at each step.

One of the predominant aspects found in the analysis of evolutionary stage models is that the authors analyzed do not reach a consensus on the number of steps in the models. The steps can be grouped into four generic stages, as Table 1 presents. The first stage addresses the lack of commitment with environmental topics and considers legislation as a driver for end-of-tube practices. The second stage is characterized by the specialization of one sector aimed at environmental management, with little integration with other sectors. The target of this sector is to improve the efficiency of the productive process through the rational use of resources. In the evolution of the initial stages, Stages 3 and 4 make evident that all the dimensions analyzed in this study (environmental management, resources, practices, integration, employees' involvement, and monitoring) advance in a cumulative and conjoint manner. Stage 3 is focused on the development of green products, the adoption of clean technologies, the systematization of environmental management, together with the initial formation of multifunctional teams and the provision of trainings to other areas. Yet, in Stage 4, environmental management has a corporate dimension, involving all employees and mainly the top management to place the company in a competitive position as a reference on the subject.

Some steps overlap stages 2 and 3. For example, although the step Emergent of Jeswani et al. (2008) is limited to legal requirements, the authors decided for the implementation of the Environmental Management System (EMS); the steps Low Hanging Cherries of Valentine (2012), Preventive of Jabbour et al. (2014) and ECO2 of Ormazabal and

Table 1
Rearrangement of the steps from evolutionary stage models and their respective authors.

	Stage 1	Stage 2	Stage 3	Stage 4
Hunt and Auster (1990)	The beginner Fire fighter	Concerned citizen Pragmatist		Proactive
Roberts and Gehrke (1996)	Inactive Reactive	Receptive	Constructive	Proactive
Hart (1997)			Pollution Prevent Product Stewardship Clean Technology	
Azzone et al. (1997)	Passive		Reactive	Innovative
Berry and Rondinelli (1998)	Unprepared (Crisis Mode) Reactive (Cost mode)			Proactive (Sustainable Business Mode
Warren et al. (1999)	Resistant	Reactive	Proactive	
Braglia and Petroni (2000)	Less-committed		More-committed	
Clemens (2001)	Cost minimization	Cost-effective compliance	Beneficial environmental control	
Buysse and Verbeke (2003)	Reactive Strategy		Pollution Prevention	Environmental Leadership
Jeswani et al. (2008)		Indifferent Beginner Emergent	Active	
Lee (2012)	Wait-and-See observer	Cautions Reducer	Product Enhancer Emergent Explorer All-round Explorer	
Valentine (2012)		Low Hanging Cherries		Diminishing returns
			Cost Saving Investments Revenue Enhancement	
Jabbour et al. (2014)	Reactive	Preventive		Proactive
Ormazabal and Sarriegi (2014, 2015, 2016, 2017)	Legal Requirements	Responsibility Assignment and Training ECO2	Systematization	Leading Green Company
			Eco-Innovative Products and Service	

Sarriegi (2014, 2015), which focus on production cost reduction through the increase in process efficiency transcend the manufacturing area through the formation of interdepartmental green-teams, the adoption of ISO 14001 and the environmental awareness of all the employees, respectively.

On the other hand, the advantages of environmental proactivity were also addressed in the models, such as the improvement in financial performance, ensuring return on investments (Clemens, 2001), and the promotion of the brand by the development of marketing and advertising strategies (Ormazabal et al., 2015). Nevertheless, in line with Schaefer and Harvey (1998), evolutionary stage models present vague and poorly defined criteria in each stage, and at times, they do not address all the dimensions considered to be drivers in our study. Consequently, some authors (Hass, 1996; Park and Ahn, 2012) report the difficulty of the practical implementation of the model as a conceptual scheme for empirical analyses, since obstacles were found to clearly differ between stages.

3.2. Typology models

Typology/Classification models aim to classify Environmental Management according to the practices implemented (Doty and Glick, 1994; Kolk and Mauser, 2002). We found five models characterized as classification or typology models, which are synthesized in Appendix B. These models arise from the empirical challenge of classifying companies in one single evolutionary stage, where multidimensions of environmental strategies are collapsed in a linear scale which, at times, follow a specific and cumulative sequence in a process of evolutionary practices (Hass, 1996; Schaefer and Harvey, 1998). Curiously, the five models found propose four classification groups for companies, which derive from two analysis of dimensions.

Typology models derive from the need for a greater understanding of the multidimensional process for the implementation of environmental management practices (Hass, 1996; Schaefer and Harvey, 1998). These models are restricted to the analysis of two dimensions at two different levels (high and low). These dimensions differ across the authors, who address the following dimensions: external factors (i), such as environmental pressure (Abreu, 2009) and exogenous risks (Vastag et al., 1996); internal management factors (ii), such as the development of environmental policies (Hass, 1996), political commitment (Winn and Angell, 2000), infrastructure and management support and environmental conduct (Abreu, 2009); and manufacture internal factors (iii), such as environmental practices (Winn and Angell, 2000), implemented technologies (Park and Ahn, 2012), and endogenous environmental risk (Vastag et al., 1996).

These models make it clear that the proactive level does not always refer to the highest levels in both dimensions. Vastag et al. (1996) and Abreu (2009), for example, who relate internal management and manufacturing factors to external pressures, argue that a defensive and strategic posture derives from greater external pressures, while the proactive innovative posture derives from less external pressures together with high internal factors, highlighting the importance of extrinsic stimuli for the practices adopted. Authors (e.g. Hass, 1996; Winn and Angell, 2000) who contrasted internal management factors with internal manufacturing factors defined proactivity as the highest level for both dimensions, since top management and production are aligned, which matches the last stage of evolutionary stage models (Hunt and Auster, 1990; Roberts and Gehrke, 1996; Berry and Rondinelli, 1998; Jabbour et al., 2014).

Nevertheless, those authors argue that in other typologies the same may not hold true, if environmental management is focused either on top management or on manufacturing. In the former, the top-down path driven by visibility factors presents high commitment with environmental policies, nevertheless, it is characterized by low potential of implementation at operational levels (Hass, 1996; Winn and Angell, 2000). Yet, in the latter (bottom-up path), conformity with regulations, production cost reduction, and competitivity prompt an operational response without the need for formal political commitments from top management (Winn and Angell, 2000), which may occur as proactive practices show positive outcomes.

3.3. Proactive practices

Both evolutionary stage and typology models address environmental management from different perspectives from a level in which commitment is almost inexistent, to a level of proactive engagement. Based on that and considering that organization that aim to grow regularly must seek a proactive environmental management, Table 2 synthesizes the organizational, operational, and communicational practices related to the proactive environmental management (González-Benito and González-Benito, 2006), their advantages and characteristics, as well as the drivers for the adoption of these practices.

Proactive practices found in the literature suggest that, overall, environmental management aims to reduce pollution, minimize the use of resources, increase efficiency, and material reuse, nevertheless, they focus on different targets: some practices aim to change processes and technologies, while other practices aim to redesign products. Practices that encompass both targets integrate stakeholders, implement environmental policies and top management support, by means of the Environmental Management System (EMS) and Green Supply Chain Management (GSCM). Nevertheless, the literature researched does not reach a consensus as to the practices that address Cleaner Production (CP) or Pollution Prevention (PP). Some practices are cited by different authors in both approaches, presenting correlation with Life Cycle Analysis (LCA), Design for Environment (DfE), Green Supply Chain Management (GSCM), reverse logistics, and the "open door" policy. Design for Environment practices, such as the use of renewable or less polluting raw materials, design for assembly/disassembly, design for reuse and recycling, reduction of packaging, and providing returnable packages (Hossain et al., 2008; Yüksel, 2008; Lucas, 2010; Gavronski et al., 2012) and increased product life cycle were commonly cited in both PP and CP. (Cagno et al., 2005; Hossain et al., 2008; Yüksel, 2008; Lucas, 2010; Gavronski et al., 2012). Similarly, examples of resource use mitigation were also found in both Pollution Prevention and Cleaner Production, such as increased energy efficiency (Yüksel, 2008), adoption of alternative energy sources (Lucas, 2010), together with the adequacy or substitution of equipment with the aim to reduce energy usage (Klassen and Whybark, 1999; Hossain et al., 2008; Yüksel, 2008; Lucas, 2010), factory layout change, use of environmental criteria for production planning and control (Yüksel, 2008) and maintenance procedures (Hossain et al., 2008; Lucas, 2010). Recycling associated to reverse logistics was also dubiously classified, through practices like waste segregation, collection and distribution of products for reuse, and reprocessing and use of byproducts (Cagno et al., 2005; Yüksel, 2008; Lucas, 2010). When defining the implementation levels of Cleaner Production, Yüksel (2008) adopted examples from GSCM, such as the definition of environmental criteria for supplier selection and inventory planning and logistics. Lucas (2010) integrated the selection of less polluting transportation methods to Pollution Prevention Practices, again establishing similarity between the two approaches. Nevertheless, based on the definition of the authors analyzed, we found practices exclusively related to Pollution Prevention, such as LCA, through the adaptation of products considering the stages of production, use, disposal, and reuse (Klassen and Whybark, 1999) and the mitigation of wasted generated (Lucas, 2010; Lozano, 2012). Yet, for both consumers and end-users.

Therefore, it can be stated that these concepts present similar characteristics in the literature. Glavic and Lukman (2007) identified such similarities and justify that the term Pollution Prevention is frequently used in North America, while Cleaner Production is a worldwide concept. Nonetheless, both concepts are used to define the different approaches suggested. Lozano (2012) revised the concept of Industrial Ecology (IE), and he argues that PP, DfE, and ecoefficiency comprise the tools for the ecological restructuring of an industry. Additionally, the author relates the Zero Emission (ZE) concept to CP.

Based on that, established definitions for Pollution Prevention, Cleaner Production, and ecoefficiency are necessary. With the aim to delimitate the differences, we considered the definitions established by the institutions that conceived the concepts. In 1991, United National Industrial Development Organization (UNEP) considered Cleaner Production to be the continuous application of integrated preventive environmental strategies for processes, products, and services, with the aim to increase efficiency and mitigate risks related to human beings and the environment. Based on the definition, it considers eight CP implementation techniques, namely: good housekeeping, input material change, better process control, equipment modification, technology change, on-site recovery/reuse, production of useful by-products e product modification (UNIDO, 2002). On the other hand, the Pollution Prevention concept was stipulated by the USA Congress in 1990, through the Pollution Prevention Act, which instituted the US Environmental Protection Agency (EPA) to disseminate information and to establish programs for resource reduction. Thus, this concept considers the waste source reduction or elimination, through the modification of processes, the incentive to use less toxic substances, the reuse of materials, anticipating recycling, treatment and final disposal. Additionally, it defines "source reduction" as any practice that includes modification of technology, equipment, and processes, product redesign, and housekeeping improvements, maintenance, training, and inventory control (EPA, 2016). Yet, the term ecoefficiency was coined by World Business Council for Sustainable Development (WBCSD) also in 1991 as a management strategy that relates financial performance with the environmental performance, creating higher value with less environmental impact. It encompasses five indispensable strategic aspects in its application, namely: *optimized process*, which prioritizes the Pollution Prevention approach; *waste recycle*, which considers the use of byproducts from other companies; *new services*, which incorporates services to the products generated in order to increase recyclability and durability; *networks/virtual organization*, which shares resources increasing the effectiveness of physical assets; and *ecoinnovation*, which aims to develop existing products with greater production resource efficiency and use efficiency (WBCSD - World Business Council for Sustainable Development, 2005).

Thus, based on the definitions presented, the three concepts present similarities in their operationalization and they can be related with the proactive practices found in the literature, as shown in Appendix C.

4. Evolutionary framework proposed

In line with other authors (i.e., Klassen and Whybark, 1999; González-Benito and González-Benito, 2006; Glavic and Lukman, 2007; Evangelinos et al., 2014) who aim to rank and classify proactive practices, we argue that practices can be group or sub-grouped into different categories. Organizational practices encompass the definition of an environmental policy, the development of procedures, the selection and implementation of practices, employees' training, monitoring, assessment and continuous improvement of the results, that is, they establish the necessary mechanisms to reduce environmental harm in a coordinated and systematic manner (González-Benito and González-Benito, 2006). Operational practices involve changes related to product and process (González-Benito and González-Benito, 2006), and they can be classified into two groups: environmental principles (i) and environmental approaches (ii) (Glavic and Lukman, 2007).

The environmental principles (i) comprise simple mechanisms of recycling, reuse of waste materials, resource minimization, waste mitigation and reverse logistics, principles that together will serve as the basis for the implementation of environmental approaches (ii). Consequently, the environmental approaches are a more complex system that demand a defined management structure, such as Life Cycle Analysis (LCA), Design for Environment (DfE), Self-regulation, Green Supply Chain Management (GSCM), Environmental Management System (EMS). Finally, communicational practices aim to disclose the environmental management actions to stakeholders (González-Benito and González-Benito, 2006; Ribeiro et al., 2012) and they comprise

Table 2
Proactive practices, their advantages and drivers.

Practices	Advantages/Characteristics	Driver				Authors
		Competitivity/ *Market approach*	Visibility	Regulation/ Legislation	Social	
Employees' involvement with the company's' environmental responsibilities and awareness of the practices through trainings	Employees have the power to deal with the environmental problems. Also, they are actively involved in the processes	x				Corbett and Cutler (2000), Theyel (2000), Wee and Quazi (2005), Küskü (2007), Lucas (2010), Pondeville et al. (2013)
Self-regulation	Adoption of a guide of practices for monitoring and improving the environmental performance. Quality control of the water, soil, and air. Strategic Environmental Assessment (SEA): flexible regulatory tool that assesses all the program.	X	x	X		Ulhøi et al. (1996), Labatt and Maclaren (1998), Kautto (2006), Chen and Monahan (2010), López-Gamero et al. (2010), Valentine (2010), Sindhi and Kumar (2012), Kuo and Chen (2013), Brown and Everard (2015)
Remediation: to treat crises or old practices or improve the technical understanding and its pollutant effects. Reduction in vibration, dust, odors, visible emissions. Air monitoring.	Local change to gain good reputation without changes in the company's policy. Generally, companies that focus on these practices had environmental problems or are highly pollutant		x	X		Gupta (1995), Labatt (1998), Klassen et al. (1999), Bowen (2000), Dahlmann et al. (2008), Yuksel (2008), Lucas (2010), Naime et al. (2015)
Recovery of byproducts for the internal production for end products. Reduction of raw material usage.	These practices seek profit and raw material savings. They also aim at innovations and the increase in ecoefficiency.	X			x	Gupta (1995), Labatt and Maclaren (1998), Corbett and Cutler (2000), Crowe and Brennan (2007), Montabon et al. (2007), Gadenne et al. (2009), Dangelico and Pujari (2010), Kabongo and Boiral (2011), Tatoglu et al. (2015), Brown and Everard (2015), Mahapatra et al. (2015), Piercy and Rich (2015), Madsen and Ulhøi (2016)
Design for the Environment (DfE): Reduction of the impacts caused by products based on optimization of processes	Partnership with new suppliers, implementation of new materials, closed-loop approach in the design stage	X	x		x	Gupta (1995), Sarkis (1998), Angell and Klassen (1999), Zhu and Sarkis (2004), Crowe and Brennan (2007), Montabon et al. (2007), Lucas (2010), Lozano (2012), Piercy and Rich (2015), Prajogo et al. (2014)
Product stewardship	Reduction of the environmental burden, minimization of nonrenewable and harmful materials in product development, considering the environmental impact from the design of the product, its packaging, and final disposal. Life Cycle Analysis (LCA). These practices deal with aspects related to production, assessment, and communication.	X	x		x	Berry and Rondinelli (1998), Sarkis (1998), Angell and Klassen (1999), Rondinelli and Berry (2000), Hossain et al. (2008), Lozano (2012), Wong et al. (2012)
Pollution prevention. Reduction at the source (raw materials and resources) Cleaner production: waste reduction and MA risk mitigation with cost reduction and productivity increase (ecoefficiency)	Investment in technologies that aim to increase the efficiency and to improve natural resource management, with automated monitoring, nanotechnology, and biotechnology. Practices focused on product and process aiming to reduce negative impacts. Application of reverse logistics, recycling, and reuse.	x	x	X		Gupta (1995), Klassen et al. (1999), Rondinelli and Berry (2000), Klassen (2001), Rathi (2003), Cagno et al. (2005), Claver et al. (2007), Yuksel (2007), Hossain et al. (2008), Lopez-Gamero et al. (2010), Lucas (2010), Gavronski et al. (2012), Loorbach and Wijsman (2013), Lozano (2012), Prajogo et al. (2014), Tatoglu et al. (2015), Brown and Everard (2015), Kumar and Shetty (2018)
Green supply chain	Suppliers, distributors, environmentally responsible end customers. Implementation of reverse logistics, stock mitigation, distribution and transport planning, material reduction in packages.		x		x	Sarkis (1998), Zhu and Sarkis (2004), Albino et al. (2009), Wong et al. (2012), Ahi and Searcy (2014), Jabbour et al. (2014), Ferreira et al. (2015), Prajogo et al. (2014)
Adoption of Management Systems: ISO 14001 and ISO 9001	Adoption of environmental policies that aim to prevent and control pollution. It includes auditing and trainings for the adoption of cleaner technologies. These practices seek competitive pricing, increase in competitivity, improvement of the company's reputation and performance. Pressures are both external and internal.	X	x	X	x	Sarkis (1998), Angell and Klassen (1999), Klassen and Whybark (1999), Corbett and Cutler (2000), Rondinelli and Berry (2000), Delmas (2002), Raines (2002), Melnyk et al. (2003), Sroufe (2003), Claver et al. (2007), Crowe and Brennan (2007), Dahlmann et al. (2008), Yüksel (2008), Gavronski et al. (2008), González-Benito and González-Benito (2008), Heras-Saizarbitoria et al. (2011), Kehbila et al. (2009), Montiel and Husted (2009), Ronnenberg et al. (2011), Sindhi and Kumar (2012), Darnall and Kim (2012), Zhu et al. (2012), Inoue et al. (2013), Ivanova et al. (2014), Piercy and Rich (2015), Prajogo et al. (2014), Teng et al. (2014), Phan and Baird (2015), Kumar and Shetty (2018)

(*continued on next page*)

Table 2 (*continued*)

Practices	Advantages/Characteristics	Driver				Authors
		Competitivity/ *Market approach*	Visibility	Regulation/ Legislation	Social	
Certification: assures that the company voluntarily complies with established standards.	Ecolabelling: company's means of communication		x	X		Claver et al. (2007), Dangelico and Pujari (2010) Lozano (2012), Brown and Everard (2015); Boiral et al. (2018)
Performance (Internal and External Auditing)	Measurement. Establishment of indices and environmental targets. Creation and internal and external disclosure of environmental performance reports (e.g.: pollution emission index, Life Cycle Assessment – estimation of the environmental impacts of the product)		x			Gupta (1995), Ghobadian et al. (1995), Ulhøi et al. (1996), Maxwell et al. (1997), Rondinelli and Berry (2000), Williamson and Lynch-Wood (2001), Wee and Quazi (2005), Dahlmann et al. (2008), Lucas (2010), Weinhofer and Hoffmann (2010), Singh et al. (2014), Kuo and Chen (2013), Maranghino-Singer et al. (2015)
Investment in marketing/media exposition of products with environmental responsibility that encompass the company's name and that disclose the environmental policies adopted.	These practices aim to provide a good reputation to the brand and its products with clients and stakeholders.		x		x	Ghobadian et al. (1995), Bowen (2000), Stone et al. (2004), Ramus and Montiel (2005), Küskü (2007), Ribeiro et al. (2012), Kumar and Shetty (2018)
Open door policy: the companies hosts visits from schools, associations, and other companies – Environmental Education Programs. Technological knowledge sharing with other companies.	Greater integration with stakeholders reduces the external pressure exerted by them		x		x	Bowen (2000), Loorbach and Wijsman (2013)

actions such as ecolabelling adoption, internal and external disclosure of environmental reports, information exchange with the community and with other companies through an "open door" policy and media exposition.

Based on the analysis of the three approaches, we designed a conceptual framework synthesizing the core ideas of the approaches, as Fig. 2 shows. The framework derives from the finding that literature does not present clear recommendations addressing the operationalization of proactive practices in structured environmental management practices. Therefore, literature either addresses proactive strategies without focusing on the operationalization and only presenting organizational practices, or it only clarifies operational practices, correlating them with the internal and external practices that originated them.

Our framework contemplates the three classifications of environmental management practices (organizational, operational, and communicational) independently. That is, the evolutionary stage concept can be applied to each individual type, and thus, the same case can present different maturity stages in each classification. We divided organizational practices into Culture and Area, considering how the company and its employees are prepared and structured, and which areas are affected. Organizational practices were placed throughout the evolutionary stages, following the categorization of environmental principles and environmental approaches. Nevertheless, considering that end-of-tube practices such as emission control and remediation are mainly motivated by regulation conformity, they were added to Stage 1. Communicational practices were placed from Stage 3 on, since visibility is only relevant after the consolidation of environmental principles and the implementation of some environmental approaches.

Initially, following an evolutionary and linear adoption of practices, Stage 1 is characterized by only presenting regulatory pressure and, thus, it encompasses the adoption of specialized teams specifically in the manufacturing area executing end of tube practices only with emergency resources and without any public disclosure of actions.

In Stage 2, teams (although still specialized) are present in the environmental, manufacturing, and logistics areas. Team are trained and guided by specific policies that demand consistent resources and adopt practices classified as environmental principles, responsible for complying with regulations and, additionally, competitivity factors, without public disclosures.

After the adoption of basic operational practices, in Stage 3 environmental approaches are implemented, which require a multi-functional team composed of employees from the manufacturing, environmental, logistics, purchases, and R&D teams trained by an Environmental Training Program that aims at monitoring and continuously improvements. Nevertheless, the environmental policy is still sectorized or focused on products, processes, or the supply chain. Encouraged by visibility, in addition to regulation and competitivity, communicational practices begin to be installed such as the adoption of ecolabelling (for new green products developed), and the disclosure of environmental performance reports. It is important to highlight that up to this stage, not all the practices listed are applied. Companies may prioritize some practices for strategic purposes and, consequently, the area responsible for environmental issues may also vary.

Nevertheless, in Stage 4, social pressure is considered of major importance, which requires the adoption of a corporate environmental policy that encompasses all the areas of the company. This step counts with top management support and awareness, since environmental management aspects are considered strategic factors in decision-making and all the necessary resources are provided. Therefore, Stage 4 integrates companies with all the environmental management practices in several areas.

Nevertheless, as explained in typology models (Hass, 1996; Winn and Angell, 2000), the evolution of proactive practices not always occurs in the bottom-up flow. The top-down adoption of proactive practices led by top management is usually driven by visibility and social

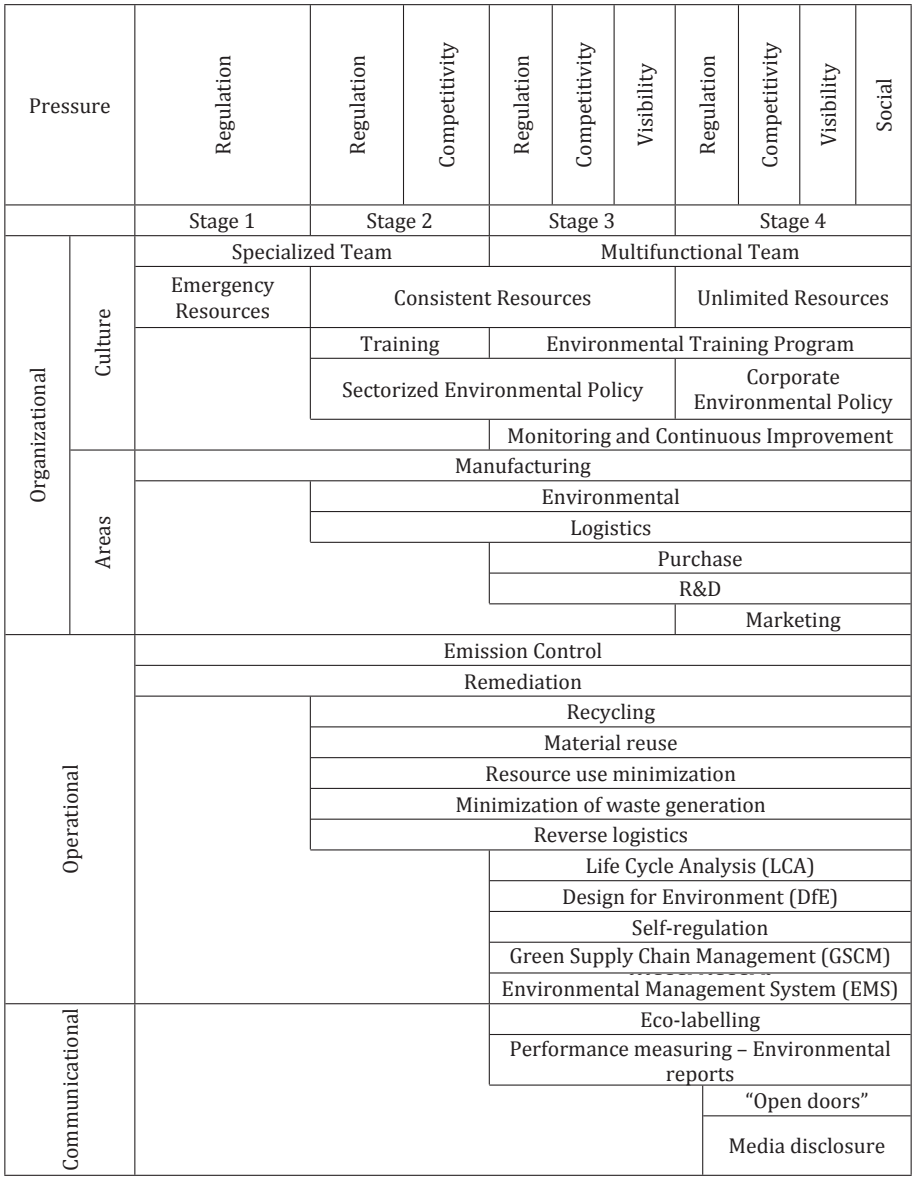

Fig. 2. Proactive practices implementation model.

pressure. Therefore, the interdependence between the practices proposed by the framework is applied, in which communicational and organizational practices of the Culture type are located in Stage 4. This stage comprises media exposure and a corporate environmental policy that encompasses multifunctional teams and an environmental training program, which is characteristic of top-down management decisions. These decisions tend to be of low effectiveness, since current operational practices and the areas involved depict early stages such as Stage 2 or even Stage 1. This is similar to the "Unrealized Greening" classification of Winn and Angell (2000), which presents high levels of structuring, political commitment and managerial support, with low levels of implementation of environmental activities.

5. Final considerations

Assessing the proactive models and practices mentioned in the literature highlights the importance of considering the dimensions independently. In evolutionary stage models, all dimensions develop concomitantly, whereas typology models treat them independently, nevertheless, these models are restricted to the analysis of two dimensions. Both premises, although necessary to the design of a model, do not necessarily correspond to the complexity of environmental management implementation in companies. On the other hand, literature reviewed indicates that proactive practices may be conducted by only one sector or area responsible, without expanding to other areas, which also contradicts the usual premises of existing models from the literature.

Therefore, the proposed conceptual framework arranges maturity levels individually under the optics of proactive practice classification (organizational, operational, and communicational), and the pressures to which each level is exposed. This allows for a broader and more complete analysis of proactive environmental practices, when compared to previously published conceptual models from the literature. In terms of guidance for managers, the proposed framework contributes to

different organizations that seek to qualify their environmental management practices, enabling them to recognize what stage they are in, as well as setting requirements for improving their positions. By comparing the practices actually employed by a company with what is widely believed to represent a certain maturity level in proactive environmental management, firms can plan the evolution of their current environmental practices as well as guide the search for additional practices that suit the current or desired level of proactivity.

As to the limitations of this study, we highlight that our search was restricted to publications in academic journals, which may have limited the number of models found. An evidence of this limitation is found in Kolk and Mauser (2002), who expanded the search to also include models published in books without peer-reviewing processes and found 50 models. On the other hand, based on the rigor from the peer review process we can infer that the 19 models analyzed in our review are sufficiently sophisticated and, in spite of their limitations, they portray the state of the art at their time. Finally, and perhaps more importantly, the conceptual framework proposed was not subjected to any kind of empirical validation, which should be sought by future research.

Given that the conceptual framework proposed has the potential to be used to guide the analysis of real cases of development and adoption of proactive environmental management practices, we suggest future studies to validate and suggest eventually necessary modifications to our framework, which can be done through interviews with environmental experts and top managers from different industrial sectors. This should enable a quantitative and a qualitative assessment of the implementation levels of firm-level proactive practices.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Conflict of interest

Author A declares that she has no conflict of interest. Author B declares that he has no conflict of interest. Author C declares that she has no conflict of interest.

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Appendix A. Synthesis of Evolutionary Stage Models

Author	Steps	Environmental Management	Resources	Practices	Integration	Employees' involvement	Monitoring
Hunt and Auster (1990)	The beginner	Unnecessary	Minimal Commitment	Inexistent	Little integration with top management	Inexistent	Inexistent
	Fire fighter	Only as necessary	Budget for problems	Solve problems as they occur	Fragmented	Focus on the environmental area with other functions	Exceptions are reported
	Concerned citizen	Worthwhile function	Consistent, yet minimal budget	Follow regulations with moderate protection	Minimal interaction with other departments	Environmental department with little autonomy and training	Generation of numerous reports
	Pragmatist	Important business function	Generally sufficient funding	Minimize negative environmental impacts	Moderate	Training for employee from the area	Consistent and objective reports
	Proactive	Priority	Open-ended funding	Actively manage environmental matters	High involvement between departments	Highly diffused training	Formalized in top management meetings
Roberts and Gehrke (1996)	Inactive	Inexistent	Minimal resources	Inexistent	Inexistent	Little involvement	Inexistent
	Reactive	Only as necessary	Budget for problems	*End-of pipe*	Environmental issues are treated separately	Poorly trained employees and employees from other functions	Little
	Receptive	Existent	Consistent, yet minimal budget	Process control	Minimal integration with other sectors	Responsibilities identified; training for key personnel	Some key parameters are monitored
	Constructive	Worthwhile function	Generally sufficient funding	*Process redesign*, Design for Environment (DfE), and cradle-to-grave	Moderate integration with other departments	Training extended to most groups; suggestions for improvement welcomed	Key parameters monitored and reported
	Proactive	Priority	Open-ended funding	Product and process design	All areas are integrated	All employees committed, trained, and involved	Regular reporting
Hart (1997)	Pollution Prevention	Pollution prevention		Mitigation of wastes, pollutants, and energy use. Adoption of ISO14001			
	Product Stewardship	Mitigation of impacts associated to the entire life cycle of the product		*Design for environment:* easy product recovery, reuse or recycling			
	Clean Technology	Investment in new less polluting technologies					
	Passive						

Azzone et al. (1997)		React to external pressures		End of tube solutions. Reduction in toxic product use	Less complex decisions are taken by the production area		
	Reactive	Formal system for environmental impact reduction		Use of clean Technologies. Water and energy reuse/recovery. Design for Environment (DfE). Product recovery. Environmental advertising	Environmental decisions are systematically included in the global planning	Formation courses with the aim to improve the environmental competencies of employees. Inclusion of R&D and production	
	Innovative	Strategic view of competitive advantage		Green products. Marketing actions	Top managers make the strategic decisions. Evaluation of investments by managers from the environmental unit	Permanent department dedicated to environmental issues. Existence of an environmental culture	Environmental performance control
Berry and Rondinelli (1998)	Unprepared (Crisis Mode)			Noncompliance with regulations			
	Reactive (Cost mode)			Compliance with regulations			
	Proactive (Sustainable Business Mode)	Environmental values are an integral part of the organization's culture	Open-ended funding	Environmental Management System	High integration with top management commitment	Environmental policies are implemented in all departments	Formal system with established metrics and objectives
Warren et al. (1999)	Resistant	Vision restricted to effluent treatment		End of tube solutions	Lack of leadership and employee commitment		
	Reactive	Commitment limited to pollution prevention		Production modification. Avoidance of the use of toxic products	Leaders and managers of little influence		
	Proactive	Pollution prevention is a priority since it provides economic advantage		Changes in both the administrative and the productive process	Leaders committed to pollution prevention	Environmental training courses. Informal exchanges among factories	Establishment of pollution prevention targets
Braglia and Petroni (2000)	Less-committed	Little external influence on environmental issues			Bottom-up decision-making; top management is poorly involved	Production area is responsible	
	More-committed	Cost reduction and better reputation for the company		New products based on (Life Cycle Analysis (LCA). Adoption of (Environment Management System (EMS) and Quality Management System (QMS)	Top-down decision-making with high involvement of top management	High involvement of the R&D area	
Clemens (2001)	Cost minimization	Environmental issues are perceived as negative in company' performance		Inexistent. The company adopts a condescending strategy (passive)			
	Cost-effective compliance	Consumers engaged in environmental issues		Strategies begin to be implemented and departments are formed for the environmental area			
	Beneficial environmental control	Environmental management is perceived as competitive		Bolder and riskier strategy, named as manipulative			
Buysse and Verbeke (2003)	Reactive strategy			*End-of-pipe*			
	Pollution Prevention	Evolution and adaptation of the environmental laws imposed	Investment opportunity		Managers of the environmental area are poorly involved in strategic planning	Employees receive few trainings	
	Environmental leadership	Competitive strategy			Environmental competence at corporate level. Stakeholder involvement		External release of sustainability reports
	Indifferent						

Jeswani et al. (2008)		Indifferent to environmental issues and regulations		Actions to improve energy efficiency aiming to reduce costs			
	Beginner		Minimal resources	Improvement in energy efficiency at low or no cost			
	Emerging	Follows the leaders of the segment		Limited to the compliance of legal requirements. Adoption of Environment Management System (EMS), although not necessarily certified			Emission benchmarking; setting emission targets
	Active	Totally developed		Changes in products and processes. Emission reduction. Use of renewable energy sources	Highly integrated		
Lee (2012)	Wait-and-See observer	Indifferent to environmental issues					
	Cautions Reducer	Initial stage		Emission reduction and process improvements	Emission values start to be integrated throughout the company		Emission target values
	Product Enhancer	Focused on product development		Reduction of production emissions. Increased energy efficiency. Implementation of eco-labels			
	All-Round Enhancer	Seen as competitive		Green product development. Reduction in production and supply chain emissions		Departments dedicated to environmental management throughout the organization	Emission target values
	Emergent Explorer	Focus on new markets and businesses	Process improvement and improvements in new plants	Investment in renewable energy and in new technologies	Company concerned in reducing emissions		
	All-round Explorer	Focus on new markets and businesses		Competitiveness in existing business areas. Use of clean technologies and fuels derived from renewable sources			Emission target values
Valentine (2012)	Low Hanging Cherries	Focus on cost reduction	Unsophisticated and inexpensive technologies	Elimination of unnecessary resources, reuse, and material recycling		Formation of interdepartmental green-teams assessing inputs, processes, and outputs to increase efficiency	
	Cost Saving Investments	Focus on technological knowledge	Formal commitment of investments. Technological solutions	Closed-loop manufacturing, industrial ecology, and total quality management		Internal involvement of R &D and external consultants	
	Revenue Enhancement	Exploration of green niches in other departments		Brand and image improvement		Marketing and consumer service improvement	
	Diminishing returns	Additional initiatives do not bring so much financial benefits		Incentives for environmental commitment despite the low financial return			
Jabbour et al. (2014)	Reactive	Only reacts when environmental problems occur	Seen as an extra cost. Potential competitiveness reduction				
	Preventive	Cost reduction based on the reduction of pollutants		ISO 14001, Cleaner Production (CP), reduction, reuse and recycling (3R), pollution control and the control of chemicals	Environmental issues are treated separately. Few employees are responsible		
	Proactive	Fundamental and strategic		ISO 14001 Cleaner Production (CP); reduction, reuse and recycle (3R); pollution control and the control of chemicals, *eco-design*, Life Cycle Analysis (LCA)	All areas are integrated		

Ormazabal and Sarriegi (2014, 2015, 2016,2017)	Legal Requirements	Legislation is the most important factor	Changes are not made to the process. Market requirements are not important		Top management commitment is considered important	
	Responsibility Assignment and Training	Compliance with all relevant regulations	New equipment and employee training. The company must comply with regulations.			Monitoring of environmental laws
	Systematization	Formalized. Environmental measures implemented in activities	Environmental Management System (EMS) certification		Top management commitment with environmental issues	
	ECO2	Cost minimization and mitigation of environmental impacts	Environmental awareness among all employees. Water and energy economy.	Employee involvement with process efficiency ideas and resource economy.		
	Eco-Innovative Products and Service		Design of new products or services. Cife Cycle Analysis (LCA)			
	Leading Green Company		Environmental references through communication and marketing			Release of environmental reports

Appendix B. Typology Models

Authors	Dimension 1	Level		Dimension 2	Level		Classifications
		–	+		–	+	
Hass (1996)	Policy implementation		x	Managerial support		x	Group 1a
		x				x	Group 1b
			x		x		Group 2a
		x			x		Group 2b
Vastag et al. (1996)	Endogenous Environmental Risks	x		Exogenous Environmental Risks	x		Reactive
			x		x		Proactive
			x			x	Strategic
		x				x	Crisis preventive
Winn and Angell (2000)	Political commitment with environmental issues	x		Implementation approach of environmental activities	x		“Deliberate Reactive” Greening
			x		x		“Unrealized” Greening
		x				x	“Emergent Active” Greening
			x			x	“Deliberate Proactive” Greening
Abreu (2009)	Environmental Conduct	x		Environmental Pressure	x		Sleeper
		x				x	Reactor
			x		x		Innovator
			x			x	Defender
Park and Ahn (2012)	Technology		x	Implementation		x	Exemplary
		x				x	Infrastructure-oriented
			x		x		Technology oriented
		x			x		Passive

Appendix C. Correlation between proactive practices from the literature and the CP, PP, and Ecoefficiency approaches

Proactive Practices from the Literature	Correlation	Approaches
Training	Training	PP
Emission, waste and effluent control	Good housekeeping	CP, PP, Eco
Recycling	Production of Useful By-Products	CP, Eco
Reuse/Recovery	On-site Recovery/Reuse	CP, PP, Eco
Resource use mitigation	Better process control	CP
	Equipment modification	CP, PP, Eco
	Technology Change	CP, PP, Eco
Design for Environment (DfE)	Input Material Change	CP, Eco
	Product Modification	CP, PP, Eco
Green Supply Chain Management ()	Networks/virtual organization	Eco
Open doors		

Appendix D. List of Acronyms

Acronyms	Meaning
3R	reduction, reuse and recycling
CP	Cleaner Production
DfE	Design for Environment
EMS	Environmental Management System
LCA	Life Cycle Analysis
PP	Pollution Prevent
QMS	Quality Management System

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