

# Environmental Management Evolution Framework: Maturity Stages and Causal Loops

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## Abstract

Environmental management has become a fundamental concern for organizations, customers, and citizens, yet there are few environmental management metrics that guide toward environmental excellence. This research presents a detailed qualitative model of the evolution of environmental management of a firm through the definition of maturity stages and causal influences. The model provides a technique for assessing maturity stages as well as steps that can assist or negate their ecological advancement. The causal-based classification helps companies to understand the need for nontechnical elements in the process, such as top management commitment. This article also contributes to the literature on integrative multimethod research, as it brings together several approaches to environmental management.

## Keywords

environmental management, causal loop diagrams, maturity stages, evolution

## Introduction

An increased awareness of the risks associated with environmental deterioration has stimulated new interest in monitoring their downstream effects (Claver, López, Molina, & Tarí, 2007; Ludevid, 2000). This heightened awareness is likely to have started with untoward events and subsequent regulatory responses (Claver et al., 2007; Fernández, Junquera, & Ordiz, 2006; Harrald, Cohn, & Wallace, 1992; Sarkis, 2001), along with pressure for transparency and corporate accountability (D'Anselmi, 2011) and demand for low-impact products and services (Park & Seo, 2006).

Existing management theory predicts a range of possible organizational responses to these pressures, ranging from minimal to revolutionary change. At one end of this range are reactions limited by direct and immediate economic effects, as regulation alone does not provide incentives to innovate and to go beyond regulatory compliance (Brunnermeier & Cohen, 2003). Somewhat more values-based perspectives posit that investment in environmental management must have some expectation of resultant economic or social returns (Kiron, Kruschwitz, Reeves,

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& Goh, 2013; K. Lee, 2011; Moon, 2007; Valentine, 2010). Moreover, stakeholder pressures, notably those coming from consumers, also have effects on corporate ecological responsiveness (Finster & Hernke, 2014; Siegel, 2009), despite the priority companies give to their shareholders' economic interests. At the other end of the spectrum are changes to beliefs and organizational culture. Some authors go so far as to rank environmental management as a "revolution" (Berry & Rondinelli, 1998; Patel, 2013).

Kiron, Kruschwitz, Haanaes, and von Streng Velken (2012) found that the number of companies including sustainability in their management agenda is growing. It is not a uniform growth process, as some companies have become sustainability leaders and have developed mature processes, while others have acted as "cautious adopters" (Haanaes et al., 2011) or are still experimenting. As the environmental maturity classifications presented in the literature are merely descriptive (Jabbour, 2010) it is difficult to assess the pathways and pitfalls found when moving toward superior levels of environmental performance.

This article describes a detailed, stage-based, prescriptive evolution framework for environmental management. Our initial application of the model indicates that companies working toward improving their environmental management go through similar patterns of behavior that appear to evolve from within the firm. We discuss these patterns in the context of stages of maturity (Fraser, Moultrie, & Gregory, 2002) and develop causal loop diagrams (CLDs) to describe possible cause-and-effect relationships that spur or retard environmental evolution. Support for systemic influences would help to identify leverage points for organizations looking to achieve excellence in their environmental practices (Senge, 1990).

## State of the Art

### *Maturity Staging Models as an Organizing Principle*

Maturity staging models deconstruct the operating processes of a firm, with each stage representing a more effective and efficient use of the firm's resources for achieving the firm's goals. The first attempts at articulating staged maturity models were focused on software development, identifying specific stages and their characteristics (Nolan, 1979). Not long after, the Software Engineering Institute articulated the capability maturity model (CMM), and later, the capability maturity model integration (CMMI), a set of prescriptions intended to advance organizations toward higher levels of maturity (Humphrey, 1989). This work has evolved into a catalog of models and products for software and business processes, including large-scale software acquisition projects (Bernard, Gallagher, Bate, & Wilson, 2004), military procurement (Sheard, Ferguson, Moore, & Phillips, 2015), human resource management (Curtis, Hefley, & Miller, 2009), and the Smart Grid (Caralli & Montgomery, 2012). Outside of Software Engineering Institute, others have used the maturity model concept to classify cybersecurity readiness (White, 2011), supply chain effectiveness (Lockamy III & McCormack, 2004), and quality management (Crosby, 1979, 1996). The International Organization for Standards (ISO) provides a second standard, ISO 33011, an advancement from its earlier 15004 statement. These standards are the basis for a uniform set of process assessment standards for determining organizational maturity, as CMMI conforms to much of ISO 33011 (Rout & Tuffley, 2007).

Identifying the relative staging of an organization's processes is at the heart of both the CMMI and ISO standards. The CMM framework identifies five stages of process: "Initial," "Repeatable," "Defined," "Managed," and "Optimizing" (Paulk, Curtis, Chrissis, & Weber, 1993). The ISO 15004 standard classifies organizations in six stages: "Immature," "Basic," "Managed," "Established," "Predictable," and "Innovating." Still, a recent literature review notes that more than half of published studies in software processes are based on the CMMI model, with most others following ISO constructs (von Wangenheim, Hauck, Salviano, & von Wangenheim, 2010).

**Table 1.** Typical Characterization of Environmental Maturity Stages.

Environmental management stage names (in increasing degrees of maturity)	Source
Crisis-oriented, cost-oriented, enlightened environmental management	Petulla (1987)
Beginner, fire-fighter, concerned citizen, pragmatist, proactivist	Hunt and Auster (1990)
Noncompliance, compliance, compliance plus, commercial and environmental excellence, leading edge	Roome (1992)
Inactive, reactive, proactive, hyperactive	Ford (1992)
Indifferent, defensive, offensive, innovator	Steger (1993)
Passive, active, proactive	Borri and Boccaletti (1995)
Reactive, active, proactive	Venselaar (1995)
Unprepared, reactive, anticipatory, high integration	Richards and Frosch (1997)
Passive, reactive, anticipatory, innovation	Azzone, Bertelè, and Noci (1997)
Unprepared, reactive, proactive	Berry and Rondinelli (1998)
Reactive, unrealized, active, proactive	Winn and Angell (2000)
Rejection, nonresponsiveness, compliance, efficiency, strategic proactivity, the sustaining corporation	Benn, Dunphy, and Griffiths (2003)
Ignorance, compliance, strategic compliance	S. Lee and Rhee (2005)
Elementary, engaged, innovative, integrated	Mirvis and Googins (2006)
Transforming, reactive, preventive, proactive	Jabbour (2010)

In environmental management, several authors have attempted to create a similar classification of maturity stages (Table 1).

Nevertheless, these classifications are merely descriptive and do not delve into the characteristics of the stages (Jabbour, 2010). While staging is a useful construct, the true value of a maturity model is seen when it includes processes and causal analyses that help organizations move forward, plateau, or devolve.

Moreover, some of these maturity models are part of co-evolutionary models. A co-evolutionary approach assumes that change may be motivated not only by direct interactions but also from feedback from the rest of the system (Benn & Baker, 2009; Volberda & Lewin, 2003). These models claim that organizations evolve in relation to their environments, while at the same time these environments evolve in relation to organizations (Porter, 2006). Co-evolution entails the nexus of open systems theory, evolutionary organization theories, complexity theory, and a particular eco-social-historical context (Porter, 2006). While the motivation for advancing environmental maturity is clearly grounded in this type of co-organizational and contextual evolution (see above), this study looks at the internal elements, as they are the instruments for change within an organization rather than external stakeholders (Winn & Angell, 2000). We hope to illuminate the internal steps followed on the path.

### *Need for Nonlinear Staging Models*

Staging models carry with them an assumption of unidirectional progress from lower to higher stages. In practice, however, firms may find a pathway to progress that is nonlinear over time, with some stages proceeding quickly, and others impeded by multiple barriers. In more severe cases, retrogression over time may occur, as programs to advance maturity are abandoned (Figure 1).

Simplistic explanations of plateau effects, such as diminishing returns to scale, can be misleading, as they imply the need for additional resources and conviction to break through barriers,

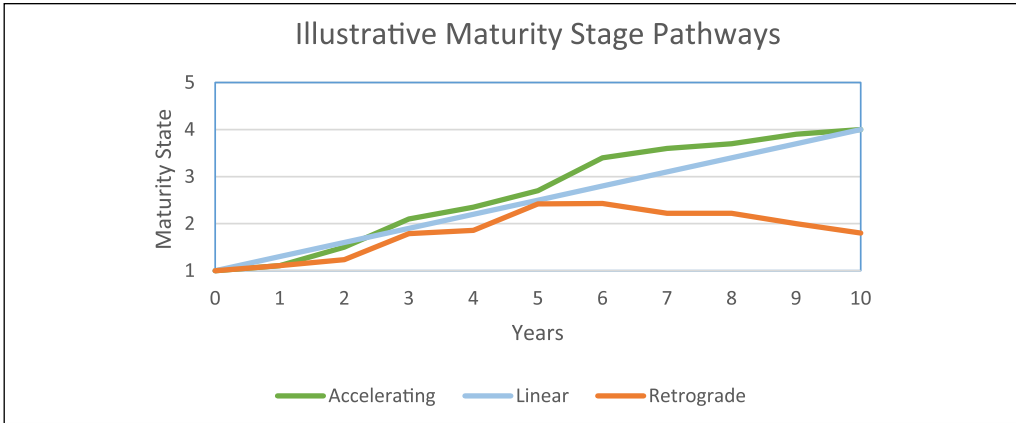


Figure 1. Maturity stage pathways.

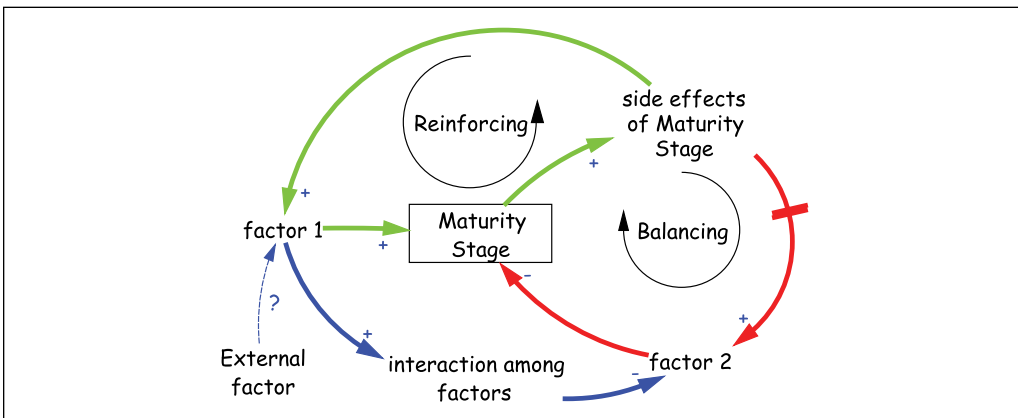


Figure 2. Feedback and nonlinear causality effects on maturity stage development.

rather than a more thoughtful reflection on the causes of success and failure. Understanding the factors and combinations of effects that influence the progression to environmental maturity requires techniques that go beyond assumptions of unidirectional progress. A satisfactory depiction of maturation processes should capture the processes that lead to success, failure, or some intermediate state. CLDs<sup>1</sup> provide a mechanism to identify the complex nature of maturation seen in practice. Let us illustrate with an abstract example (Figure 2).

Assume that there are two internal factors that affect the ability of an organization to advance its maturity state. A factor that adds to the maturity state of the organization, such as formalization of processes, can generate side effects that encourage additional formalization, creating a reinforcing and growth feedback loop. A factor that reduces or impedes maturation, such as employee resistance, may grow from other side effects, balancing or degrading the reinforcing effects gained earlier. Explicit capture of the interactions between factors as well as external effects outside the nominal boundary of the firm informs our expectations for the maturity stages ultimately achieved. This explicit causal structure illuminates both the desired and undesired outcomes of programs designed to advance organizational maturity.

Some authors have successfully used this methodology to explain the evolution of complex organization and technical problems (Sarriegi, Torres, & Santos, 2005). CLDs are one tool used to depict complexity through holistic causal models. The development of systems thinking, and

particularly system dynamics, has to do with the ability to see the world as a complex system, in which “everything is connected to everything else” (Sterman, 2000). These interrelations often take years to affect each other. While most observers tend to focus on isolated parts of the system, the only way to understand the system is by contemplating the whole as well as individual parts of the pattern (Senge, 1990).

## **Method**

Our study follows a common process for dynamic model development, starting with data collection through interviews, followed by collaborative causal modeling, and a refinement of the model based on reflection from domain environmental managers through additional interviews and a targeted survey. This approach has been used in environmental stakeholder modeling as well as extensions into dynamic analysis of environmental problems (Elias, 2012; Stave, 2002).

### *Information Gathering Through Interviews*

In the Information Gathering step, interviews were conducted with environmental managers from 19 enterprises among different industrial sectors in the Basque Country of Northern Spain. These companies were randomly selected, taking into account that the main objective was to gather information about general factors that affect environmental management as well as to understand how environmental management has been deployed in each enterprise. Once the environmental factors were noted to be similar among companies, we ended the interviews. Consequently, the sample size was not chosen in advance but was determined when we had enough information for our study. The average face-to-face interview lasted about 75 minutes. Some of the companies were just beginning to deploy environmental management while others were quite advanced. The study included firms from different sectors such as chemical products, automotive manufacturing, railway manufacturing, elevator design and manufacturing, and electrical equipment manufacturing.

### *Information Processing Through Group Model Building Workshops*

The factors and the early causal model were used in the second step as the information that needed to be processed. To assist in the synthesis of these results, two Group Model Building (Vennix, 1996) workshops were conducted with a panel of six participants of different environmental profiles. The participants included environmental managers of different enterprises, environmental consultants and academics with experience in environmental projects. In the first workshop, exercises included activities regarding stakeholder identification, policy options, and proposals for maturity stages and indicators. In the second workshop, participants discussed the dynamic behavior of the most significant indicators, providing a reference mode for a complete evolution of the maturation process. These exercises helped the researchers to understand the underlying structure of the process of environmental maturity and how interconnections within it drive the proposed reference mode. Researchers found causal relationships among the information obtained from the participants; a preliminary CLD model that captured elements of the transition among stages was developed. Finally, the workshop participants reviewed and improved this model.

### *Information Validation Through Surveys and Interviews*

Using the results of the workshops, our team developed a survey instrument to elicit comments about the model’s generalizability from a wider audience (Forza, 2009). A sample of firms from public catalogues of exporting companies based in Italy and Spain were sent an online survey. Out of 588 solicited firms, 215 firms accessed the online survey link and 92 completed it (16%).

This relatively low gross response rate may be due to concerns about spam and junk mail (Sills & Song, 2002). Within those firms that accessed the survey, however, 43% responded in part or completely to our request for information; this value is at the high end of typical large study response rates of 10% to 50% (Nawrocka & Parker, 2009). Thirty-seven questionnaires were incomplete and were removed, leaving a final sample of 55 firms, 29 Italian, and 26 Spanish (Ormazabal & Sarriegi, 2014).

The questionnaire has four parts (Appendix A). In the first part, the proposed maturity stages are defined and respondents are asked to order the different maturity stages in ascending evolutionary stages. The stages are ordered alphabetically to avoid influencing respondents, and the options of marking some stages as parallels, deleting others, or adding additional ones for ranking are offered.

The second part of the questionnaire focuses on activities and actions that take part in each maturity stage and the apparent degree of their importance. The respondents are asked to consider the importance of 10 factors for each maturity stage, ordered by a 4-point scale. Respondents could add new factors as well.

The third part requested the reaction of the informants to the survey. The last part consisted of general information about the companies.

After this survey among Spanish and Italian companies was analyzed, the CLD model was updated, and a second survey was developed to validate the updated model. We identified a group of environmentally proactive companies in the United Kingdom, anticipating they would have progressed further in the evolution of environmental management, and have more relevant data about their progress into later stages. The second short survey (Appendix B) was sent to 273 companies and was answered by 55, obtaining a response rate of 20%.

The first question asks whether they (the respondent) agreed with the order of the proposed maturity stages. The second asks the respondent to identify their firm's current maturity stage. These questions are followed by an open-ended question tracing the subject firm's own procession through the proposed sequence of stages. The final question asks respondents to score proposed factors embedded in the causal model and score their relative influence on their current maturity stage.

Ten responding companies were identified and a semistructured interview (DiCicco-Bloom & Crabtree, 2006) with the environmental manager of each of these companies was carried out. Each interview lasted about 60 minutes. The informants were asked about the environmental management milestones achieved in their progress to their current state. The analysis and intermediate results of the U.K. survey and interviews are presented in Ormazabal, Sarriegi, Barkemeyer, Viles, and McAnulla (2015).

## Results

It appears that many progressive companies perceive their movement toward constructive environmental management as unique, focusing on the particulars of their firm and its context. Our sample indicates that these firms have more in common with each other than they realize, as they appear to go through the same steps toward environmental excellence (Figure 3).

As a result of the validation, the maturity stages were renamed slightly. The final six maturity stages are Legal Requirements, Responsibility Assignment and Training, Systematization, ECO<sup>2</sup>, Eco-Innovative Products and Services, and Leading Green Company.

In this section, we present the six maturity stages and illustrate one set of causal loops that underlie them. These causal models form the basis for prescriptive environmental management evolution that might help companies reach environmental excellence effectively and efficiently.

### *Stage 1: Legal Requirements*

A common starting place for companies examining their ecological maturity is examining the regulatory environment. They determine the pertinent ecological impact and compliance requirements,

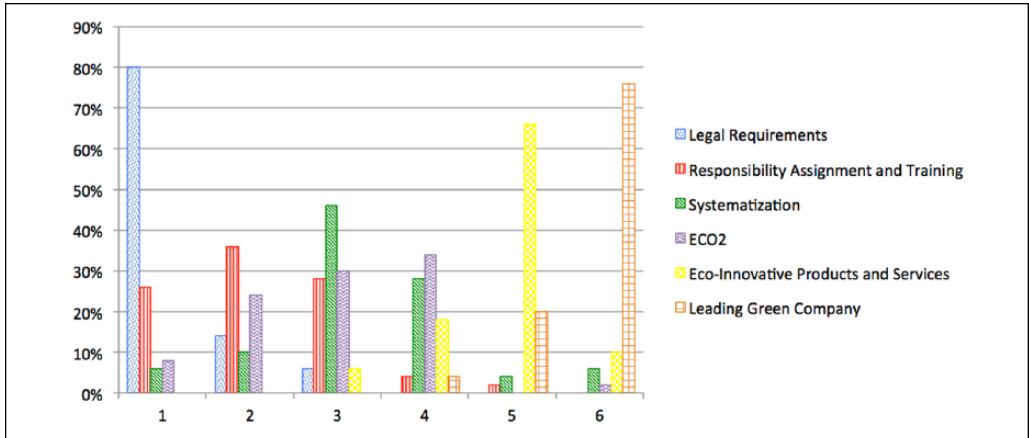


Figure 3. Maturity stage ordering according to the surveys.

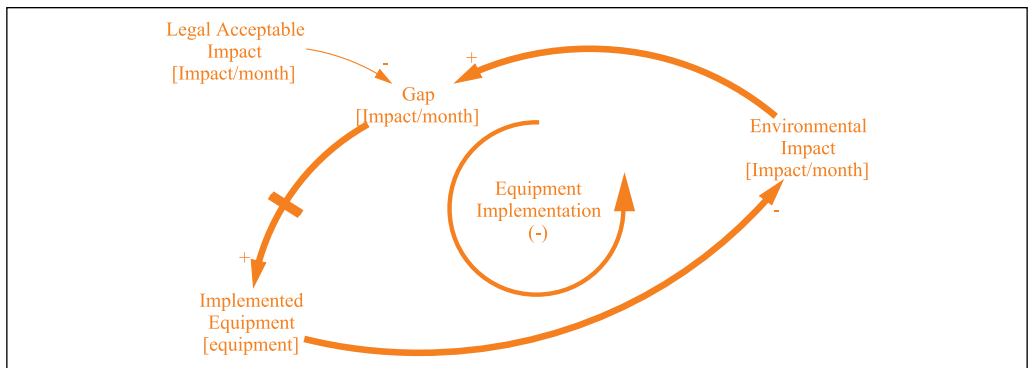


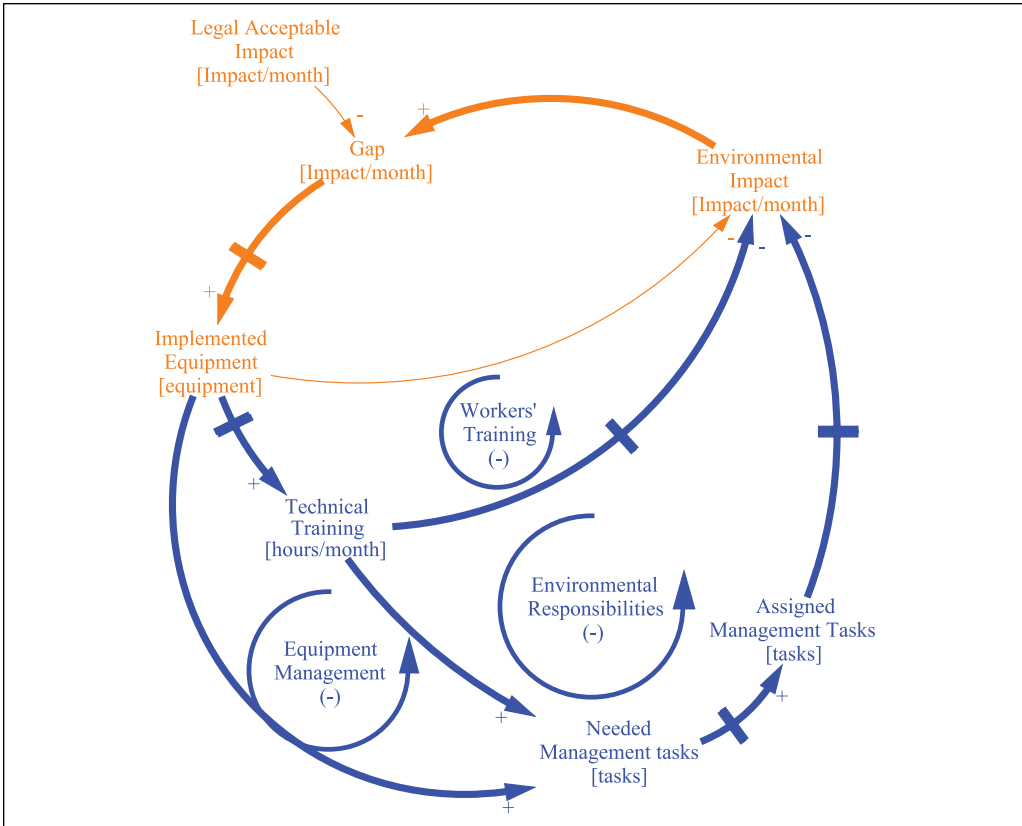
Figure 4. Stage I: Legal Requirements.

and identify the laws that the company is in danger of or actually violating. This often results in “end-of-pipe” actions and investments in new equipment (Figure 4).

When the dynamic perspective is considered, actions and reactions are addressed. Thus, when legal requirements increase, the *Legal Acceptable Impact* will be lower and consequently, the *Gap* is bigger. In turn, this drives the implementation of new equipment and the *Implemented Equipment* increases (Testa, Iraldo, & Frey, 2011). This leads to a reduction of *Environmental Impact* that closes the *Gap*, completing a balancing causal loop, *Equipment Implementation*. The environmental impact variables are measured with tons of CO<sub>2</sub> emitted per month, as a generalized scale across a variety of emission and outputs produced by the company (Wiedmann & Minx, 2007). On the other hand, *Implemented Equipment* is measured by the amount of equipment that has been implemented within the company. This, in turn, influences the amount of CO<sub>2</sub> emitted.

### Stage 2: Responsibility Assignment and Training

As part of the advancement to a more mature stage of environmental management, an environmental manager must be responsible and workers may be trained in skills to fulfill their environmental responsibilities (Wee & Quazi, 2005). In the second stage, the earlier causal structure is supplemented with *Responsibility Assignment and Training*, where three new variables influence



**Figure 5.** Stage 2: Responsibility Assignment and Training.

the system's behavior: *Technical Training*, *Needed Management Tasks*, and *Assigned Management Tasks* (Figure 5).

In this second stage, *Environmental Impact* is mitigated by four different factors, corresponding to four balancing loops, corresponding to the implementation of more equipment (*Equipment Implementation*), using the equipment more effectively (*Equipment Management*), training the workers (*Worker's Training*), and by managing the training and equipment correctly (*Environmental Responsibilities*).

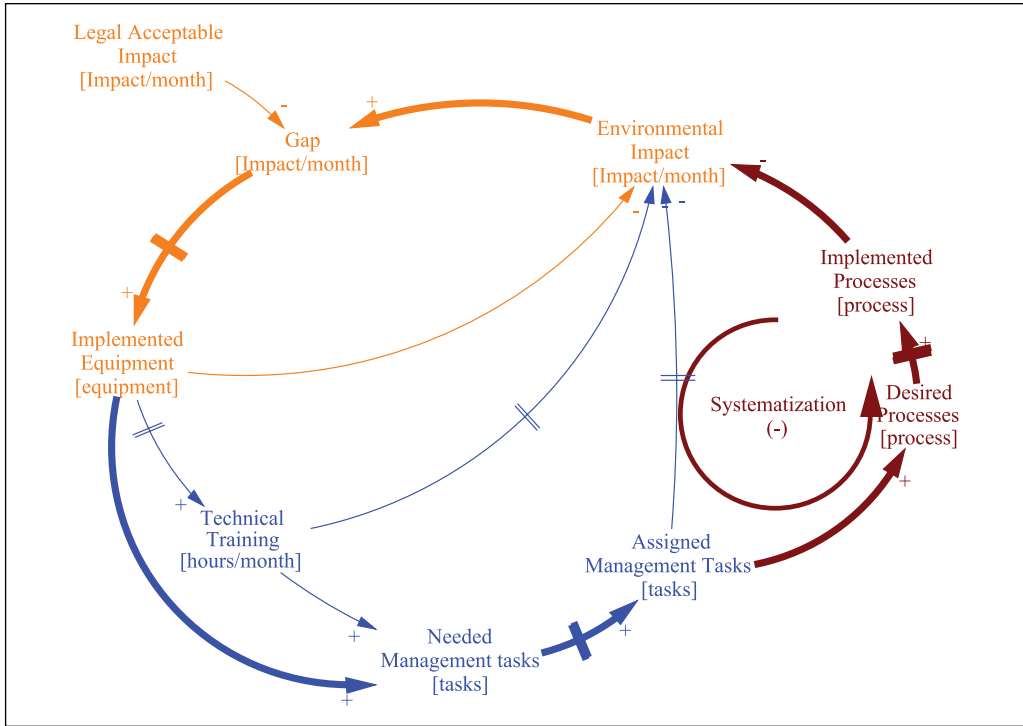
As *Implemented Equipment* increases, additional *Technical Training* is needed so that the organization can make the most of the implemented equipment, decreasing *Environmental Impact* and forming a balancing loop called *Workers Training*. *Technical Training* is measured in hours per month to reflect the time devoted to environmental training.

The *Technical Training* and the *Implemented Equipment* lead in turn to an increase in the *Needed Management Tasks*, which in turn will lead to the assignment of some management tasks, which are followed by a decrease in *Environmental Impact*. As Jabbour (2013) stated, environmental training is fundamental to any successful implementation of environmental management.

### Stage 3: Systematization

At this stage, the company begins to systematize good environmental practices. The trigger is the increase in the *Assigned Management Tasks* that requires the adoption of formalization of the





**Figure 6.** Stage 3: Systematization.

company’s environmental management, resulting in the implementation of superior environmental processes (Figure 6).

As this stage of maturity, *Assigned Management Tasks* lead to an increase in *Desired Processes* in the company. This will lead to more *Implemented Processes* which will lead to a decrease in the *Environmental Impact*. Both are measured by number of processes. This creates a fifth improvement mechanism, *Systematization*. Sometimes this *Formalization* can be seen in the form of certification, such as ISO 14001 (Coglianese & Nash, 2002; López-Fernández & Serrano-Bedia, 2007), EU Eco-Management and Audit Scheme, or local recognition (Alonso-Pauli & André, 2015).

**Stage 4: ECO<sup>2</sup>**

This fourth stage, ECO<sup>2</sup>, is where companies obtain ecological and economic benefits (Armas-Cruz, 2011; Suzuki, Dastur, Moffat, Yabuki, & Maruyama, 2010). As improvements accumulate, companies will start to achieve operational savings (Figure 7).

In this stage, as the *Implemented Processes* increase, economic *Benefits* will increase, which in turn will lead to higher *Top Management Commitment*. When the top management is more committed to environmental issues, *Desired Processes* will increase and the number of *Implemented Processes* will also increase (Martin-Pena, Diaz-Garrido, & Sanchez-Lopez, 2010; Ronnenberg, Graham, & Mahmoodi, 2011).

This combination of effects creates a reinforcing loop, *Top Management Involvement*. This is the first structure in the model that accelerates the integration of environmental practices. It is within this evolutionary stage we envision proactive behaviors and the derivation of benefits from the environmental management.

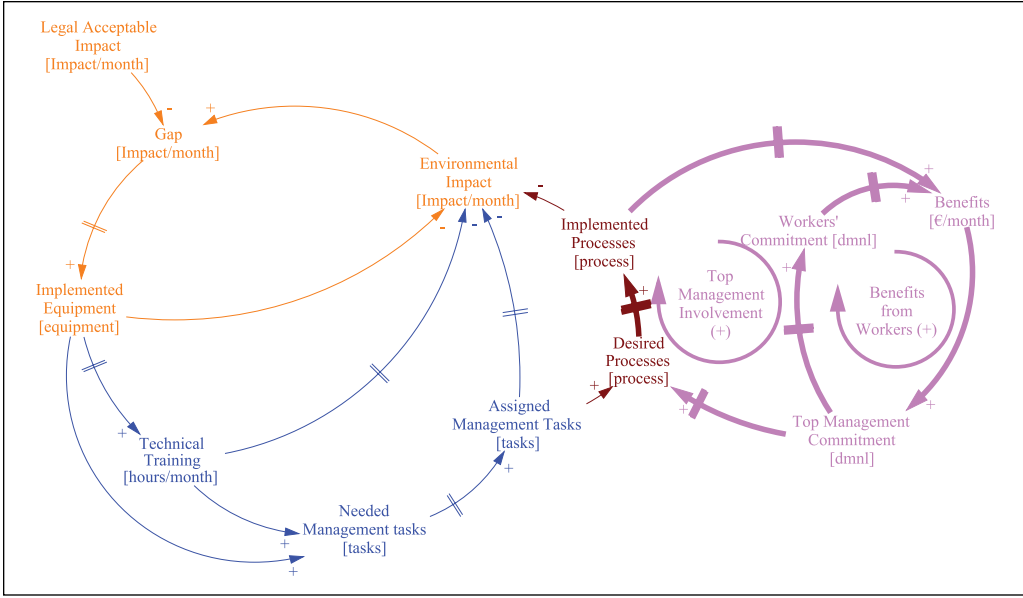


Figure 7. Stage 4: ECO<sup>2</sup>.

A second reinforcing loop in this stage is called *Benefits from Workers' commitment*. When management is committed to environmental issues, it will promote similar environmental commitment from employees. Employees who engage this commitment might provide opportunities for improvement (Govindarajulu & Daily, 2004; Lanfranchi & Pekovic, 2014). Consequently, this *Workers' Commitment* is part of the growth of *Benefits*, which in turn further increase in the *Top Management Commitment*.

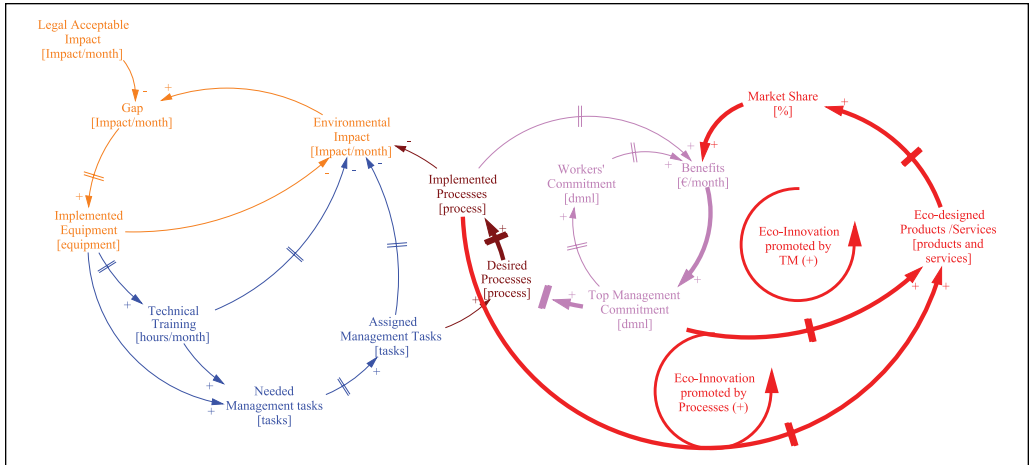
The final loop in this stage captures the combined growth of commitment and processes on the firm's environmental impact. When management and workers are committed to the course of environmental activity, the *Environmental Impact* of the company will be lower, achieving the mitigating opportunities identified in the earlier three stages.

### Stage 5: Eco-Innovative Products and Services

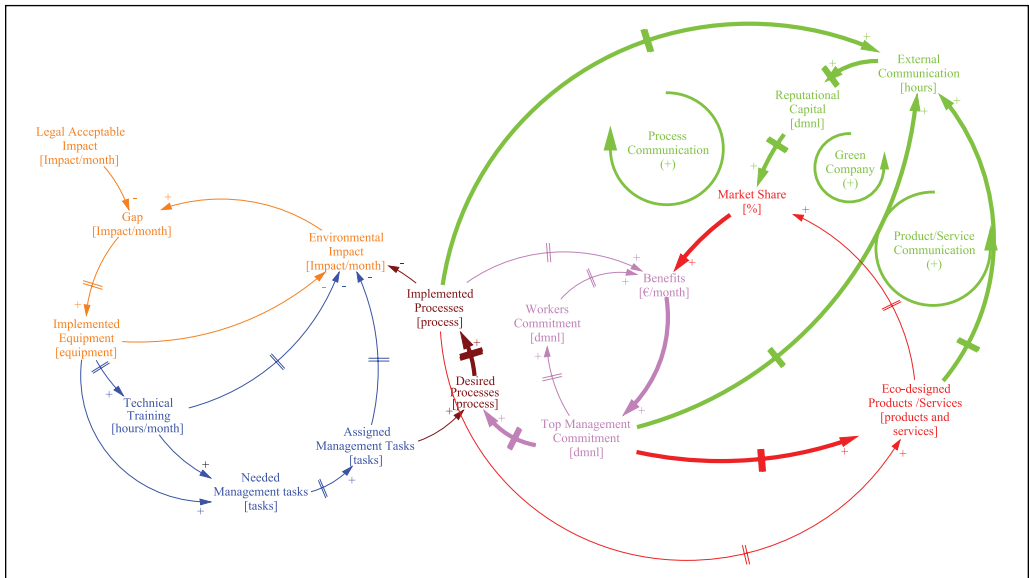
Once companies begin realizing operational savings, they may recognize the value of new green products and/or services to the activities of the company. As a consequence, they will need to design products and services that minimize environmental impact (De Bakker, 2001; Triguero, Moreno-Mondéjar, & Davia, 2013; Wee & Quazi, 2005). In this stage companies tend to be quite proactive; as a result, they innovate and consequently they gain more customers (Figure 8).

The two reinforcing loops in this stage continue the acceleration of innovative environmental practices within the firm. *Eco-Innovation promoted by Top Management* captures the drive of managers who have recognized the gains from the previous stage to design more products or services from a green perspective. This will lead to an increase in the variable *Eco-Designed Products/Services* and as a consequence, an increase in the *Market Share*, increasing the *Benefits* and additional *Top Management Commitment*.

A second reinforcing loop, *Eco-Innovation promoted by Processes*, follows from an increase in the *Implemented Processes* derived from managerial commitment. New green products and/or services will be created, resulting in higher *Market Share*, which in turn results in higher *Benefits* and hence, an increase in *Top Management Commitment*. The Top Management will then demand more processes, and consequently, the number of *Implemented Processes* will grow.



**Figure 8.** Stage 5: Eco-Innovative Products and Services.



**Figure 9.** Stage 6: Leading Green Company.

**Stage 6: Leading Green Company**

Once the stage of Eco-Innovative Products and Services has been reached, the company is poised to become a leading green company (Figure 9). Companies begin to make their environmental practices public and can now compete on their environmental stewardship. Some companies communicate their performance through environmental labeling (Dudley, Elliott, & Stolton, 1997). Others decide to issue corporate environmental reports (Koehler & Chang, 1999). Some researchers call these companies “embracers,” sustainability leaders within their industry (Haanaes et al., 2011).

The influence and extent of *External Communication* is based on the exploitation of the products of earlier stages. *Process Communication* captures the growth of benefits to the firm when their superior processes are exposed to the marketplace, leading to an increase in *Reputational Capital* and consequently in *Market Share*, which will result in additional *Benefits* to the firm.

A second reinforcing loop occurs as the Eco-Designed Products/Services available through the firm are advertised to the marketplace, through *Product/Services Communication*. Leveraging the benefits of the *External Communication* loop, *Top Management Commitment* will increase and will demand more green products/services, leading to encouragement of additional market offerings.

The last reinforcing loop, *Green Company*, depicts the secondary effects of successful *External Communication*. As communications increase *Reputational Capital* and *Market Share*, their Benefits will sustain and increase *Top Management Commitment* to visibility and additional investments in communications.

## Conclusion

We developed a prescriptive framework for the evolution of environmental management practices. This framework contributes to the literature by adding a dynamic causal model that captures a process for movement among stages. Our proposal is supported through the use of complementary techniques of grounded theory model-building combined with data review and corroboration through validation surveys. This provides a technique for assessing maturity stages as well as steps that can increase or negate their ecological advancement. Our causal-based classification helps companies to understand the need for nontechnical elements in the process, such as top management commitment.

Our initial analysis of the causal model depicts balancing loops with the later emergence of multiple reinforcing loops. Readers should consider how these early stages may be characterized by limited results and resistance, and that accelerated, highly leveraged results may only occur once these early stages are past and limits overcome. This is rather speculative, as CLDs are not conclusive, and should be supplemented with formal simulation that captures systems complexities more rigorously.

As is the case with many projects of this nature, our research has some limitations which we have identified and analyzed (King & He, 2005). Our work is intentionally general for industrial companies, and does not reflect the specific characteristics of individual companies. Moreover, it has not been possible to implement the full model in a company as this implementation may take quite a long time depending on the company's particularities. Another limitation, which has already been mentioned, is that this model is mainly focused on internal elements. Technologies may not be available for advancement, funding may not be available or other firms' competitive actions may limit options.

Subsequent research may expand on the interrelationships among companies and external entities, such as suppliers, as it would extend the boundary of the model to include the effects of strategic partnership on environmental management introducing this internal system into a co-evolutionary theory.

Another direction in future research is the implementation of the whole model in a company that is beginning to examine environmental issues while observing the direct results of the implementation of the model.

On the other hand, as the model is quite general and can be adapted to almost all types of companies, future research can also focus on specific sectors, so that the model can be more detailed depending on the sector in which it is operating.

Moreover, future research should shed light on different trajectories between manufacturing and service firms. In particular, it should explore why some companies appear to become trapped in specific maturity stages and do not develop their environmental management activities further.

## Appendix A

The Spanish and Italian survey is presented in this appendix.

### 1.- Identifying the evolution's maturity stages

Our objective is to check how the environmental management really evolves within the firms. So, let's answer to the questions NOT thinking to how the evolution SHOULD BE in an ideal way, but to HOW IT IS.

In the evolution model we're designing we've identified some maturity stages which almost every firm gets across; here they're shown in ALPHABETICAL order:

ECO2: the firm tries to reduce its costs thanks to environmental management

ECO-INNOVATION: the firm develops and/or uses some environmental tools to design products, processes or services more "green"

LEADING GREEN COMPANY: the firm takes care to externally share and communicate its environmental practices and it is socially recognized as a reference in matter of environmental management.

LEGISLATION FULFILLMENT: the firm takes care to comply with minimum requirements giving by existing legislation

SYSTEMATIZATION: there is a formalization of the environmental management, and sometimes the company tries to reach an environmental certification

TRAINING: the firm tries to train its workers in using new equipments or new measures that are being implemented.

#### 1. Do you think there are any maturity stages missing? If yes, explain it

Added Stage 1:

Added Stage 2:

Added Stage 3:

#### \*2. Put the different stages in the order in which they appear in the evolution of a firm's environmental management.

"1" means that the maturity stage is the first to appear in chronological order; "9" means that is the last one (in case you think appear nine separate maturity stages). You can use the same ranking for more stages meaning that they're parallel. You can also add in the ranking the missing stages identified previously. If you think the stage doesn't exist or couldn't be strictly considered as a "maturity stage", choose the option "no".

	no	1	2	3	4	5	6	7	8	9
ECO2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eco-Innovation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leading Green Company	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation Fulfillment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Systematization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your added Stage 1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your added Stage 2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Your added Stage 3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### 2.- Identifying the factors in each maturity stage

Here there is a brief description of the factors that you're going to evaluate:

ENVIRONMENTAL MEASURES AND ACTIONS: represents the intensity of the actions in matter of environment to lower the firm's environmental impact

EXTERNAL COMMUNICATION: represents the way in which the firm communicates externally its environmental commitment and its results about environmental issues

FORMALIZATION: measures the firm's grade of systematization in its environmental management (with the possibility of certifying it)

GREEN IMAGE: measures in what way the market perceives the company as committed to the environmental issues

GREEN PRODUCTS AND PROCESSES: measures how the firm is able to develop innovative processes and products with low environmental impact

LEGISLATION: measures the intensity in which the legislation affects the firm's strategies and commitment in matter of environment (with laws, penalties...)

**MARKET REQUIREMENTS:** measures the market's influence on the firm's environmental management strategies/commitment

**PROCESS EFFICIENCY AND SAVINGS:** indicates in which way the firm is able to achieve savings and efficiency in its processes thanks to the environmental management

**TOP MANAGEMENT COMMITMENT:** measures how the Top Management is committed to environmental issues

**TRAINING:** measures the intensity of training given to employees to use environmental friendly technologies and/or to increase their commitment about environmental issues)

**3. Which factors take part in the "ECO2" stage? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**4. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1:

Factor 2:

Factor 3:

**5. Which factors take part in the "Eco-innovation" stage? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**6. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1:

Factor 2:

Factor 3:

**7. Which factors take part in the "Leading Green-Company" stage? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**8. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1: Factor 2: Factor 3: **9. Which factors take part in the "Legislation fulfillment" stage? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**10. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1: Factor 2: Factor 3: **11. Which factors take part in the "Systematization" stage? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**12. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1: Factor 2: Factor 3: **13. Which factors take part in the "Training" stage? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**14. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1: Factor 2: Factor 3: **15. Which factors take part in "Your added stage 1"? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**16. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1: Factor 2: Factor 3: **17. Which factors take part in "Your added stage 2"? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**18. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1: Factor 2: Factor 3: **19. Which factors take part in "Your added stage 3"? In what measure do they take part?**

	1. No influence	2. Very low	3. Low	4. High	5. Very High
Environmental measures and actions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
External communication	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Formalization	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green Image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green product and processes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processes efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



**20. Do you think there are any factors missing?**

Rate in what measure they take part as done with the previous ones.

Factor 1:

Factor 2:

Factor 3:

**3.- Feedback**

**21. Once you have read our questionnaire, understanding the maturity stages we've identified, does it help you to put your company in one of the maturity stage?**

NO

YES: which of them? why?

**4.- Information about the firm**

**22. Name of the company:**

**\*23. Number of workers:**

0-10    11-50    51-250    >250

**\*24. Organizational sector:**

Manufacturing

Other: please specify

**\*25. How could you define your market size?**

Local    Regional    National    International

**\*26. What is the task in the company of who have filled the questionnaire?**

CEO

Environmental Manager

Other:

**27. Do you want to receive a feedback about the results of this questionnaire?**

No

Yes; this is the email where I want to receive it

## Appendix B

This section presents the survey that was made among U.K. companies.

### Environmental management evolution in your company

In this section we are looking at how corporate approaches to environmental management evolve over time.

In our previous research we have identified the following stages which firms tend to progress through towards environmental excellence:

1. **LEGAL REQUIREMENTS:** the firm identifies environmental regulations and introduces new equipment.
2. **RESPONSIBILITY ASSIGNMENT AND TRAINING:** the firm assigns an environmental management responsible and trains its workers in using new equipment, such as air quality monitors or new measures that are implemented.
3. **SYSTEMATISATION:** environmental management is formalised, and sometimes environmental certification is achieved.
4. **ECO2:** the firm reduces its costs due to environmental improvements in its processes.
5. **ECO-INNOVATIVE PRODUCTS AND SERVICES:** the firm develops and/or uses some environmental tools to design "greener" products or services.
6. **LEADING GREEN COMPANY:** the firm externally communicates its environmental performances and it is recognised as a leader in environmental management.

As not all companies are at the same level of environmental management, we are interested in finding out about your company's position.

**\* 1. Do you agree with the order we have proposed above?**

- Yes
- No (please comment below)

Comment

**\* 2. In which state is your company right now?**

- Legal Requirements
- Responsibility Assignment and Training
- Systematisation
- ECO2
- Eco-Innovative Products and Services
- Leading Green Company

**\* 3. Has your company passed through all the previous states until reaching the present state?**

- Yes
- No (please, state below which states have been omitted)

Omitted states

**\* 4. In your own experience, to what extent have the factors below acted as drivers to reach the present state of environmental management in your organisation?**

	1-Small influence	2	3	4- A great influence	N/A
Corporate image improvement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Productivity increase	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Top Management Commitment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Process efficiency and savings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Innovation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Society Requirements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
International trade barriers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market Requirements (customers, competitors, suppliers...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Market position (market share) improvement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Internal environmental awareness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other/s (please specify)

### Company profile

All information provided in this survey will remain strictly confidential. However, as the respondent's position within/relation to the company might affect the survey outcome, we would like to kindly ask you to fill out the personal information below. Your email contact will not be used for any other purpose than this specific research project.

#### 15. Company

Organisation name	<input type="text"/>
Country	<input type="text"/>
Sector	<input type="text"/>
Number of employees	<input type="text"/>
Your name	<input type="text"/>
Email address	<input type="text"/>

**16. Who in the company decides which standards are used?**

- Specialists in particular areas
- General managers
- CSR committee or similar
- Other (please specify)

**17. Are you a member of any of the following?**

- Company board
- CSR Committee
- Environmental management team
- Marketing/branding team
- Communications team
- None of the above

**18. If you would like a copy of the results of the project please tick here:**

- Yes

**19. FUTURE RESEARCH**

**We would like to interview some of you so you can provide us with detailed information about your organisation with respect to the evolution of environmental management in your company and the use of standards. Participants will have the opportunity to receive feedback on the current state of environmental management within their company and ways to progress further.**

**Would you be interested in taking part in this further research?**

- Yes
- No

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**Note**

1. A causal loop design (CLD) depicts dynamic variables connected by links denoting the causal influences among the variables. Each causal link is assigned a polarity, either positive (+) or negative (-), to indicate how the dependent variable changes when the independent variable changes. A positive link means that if the cause increases, the effect increases, and if the cause decreases, the effect decreases.

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