The drivers for adoption of eco-innovation

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Abstract

Considering the highlighted importance on understanding why and how companies integrate environmental sustainability into innovation process, it is important to question: *How has 'eco-innovation' been researched in business literature related to the drivers that boost the adoption by the companies? What are the drivers and motivations for the adoption of eco-innovation by companies? How could results from the literature help to define a conceptual framework of eco-innovation drivers and motivations?* To address these questions, a systematic review was conducted. After defining inclusion and exclusion search criteria, the search of peer reviewed papers from the *ISI Web of Knowledge* database was systematically applied. The final database remained with 96 full papers, of which 35 matched the specific target of analysis that focused at: i) Eco-innovation's concepts and approaches; ii) Methods and main findings; and iii) Drivers and motivations for adoption of eco-innovation. Results indicated that there is a growing interest in this concept, not only from a managerial but also from an academic perspective (64% of papers were published after 2010). Different methods are used in the selected papers and evidences show that leading firms are protagonists in developing new technologies. Although undertaking punctual actions was enough to recognise eco-innovation in some cases, companies need to improve the focus in eco-innovation as an explicit goal of their strategies to boost performance. This paper contributes pointing out internal factors that companies can manage in order to fully adopt eco-innovation, going beyond mere compliance of external factors, over which companies have little or no control. Based on the systematic review, this article draws propositions and proposes a conceptual model for further empirical research on eco-innovation.

Keywords: eco-innovation; environmental sustainability; systematic review.

1. Introduction

Bearing in mind that industrial society is trying to establish alternatives that mitigate environmental risks derived from its activities (Korhonen, 2001), innovation and environmental sustainability become central concepts and both should be well assimilated in companies' management and coordination activities. Innovating in green products is a way of integrating innovation and sustainability and can be a key factor to achieve increased growth rates for companies, and a better quality of life for society (Dangelico and Pujari, 2010).

Traditionally, environmental strategy has been considered by companies as an approach that contradicts aims of growth, competitiveness and profitability of the business (Andersen, 2004; Porter and Van Der Linde, 1995). At the same time, economic growth is associated with environmental damages, and economic expansion is directly dependent on innovation. Due to the fact that environmental consumer awareness is rising, as well as social and government pressures on companies to reduce their environmental impact (Bocken et al., 2011), to succeed strategically and economically, companies must take into account social and environmental issues when developing a novelty (Medeiros et al. 2014). Within this context, the concept of eco-innovation arises.

The Organization for Economic Co-operation and Development (OECD) defines eco-innovation as "the development of products (goods and services), processes, marketing methods, organizational structure, and new or improved institutional arrangements, which, intentionally or not, contribute to a reduction of environmental burdens in comparison with alternative practices" (OECD, 2009, p. 2). Like innovation, eco-innovation is multi and transdisciplinary (Boons and Lüdeke-Freund, 2013; Fagerberg, 2005; Santolaria et al., 2011), which leads the use of different expressions related to the same approach or subject, e.g., sustainable innovations, environmental innovations, green innovations and eco-innovations, the latter being the main expression used in this article.

Considering that the OECD concept is not restricted to the intentionality of the environmental improvement, it becomes of great importance to verify what the drivers and motivations are for companies to adopt environmental precepts. Although lately, either in academic and practical debate, issues such as innovation and sustainability are hot topics, what companies are really doing and how they are integrating those concepts in their activities and strategies is not clear.

Eco-innovation is grounded in a less inclusive scope than innovation, since it encompasses limiting characteristics, as the basic principle of reduced environmental burdens. Eco-innovation can bring some positive trade-offs between environmental attributes and critical success factors, for instance style, design and performance. Eco-innovations should have a positive effect on organisational and consumption practices, as well as should comprise social, economic and environmental dimensions in their adoption and implementation in order to succeed towards sustainable development direction (Hellström, 2007).

It is clear that companies are increasing the adoption of sustainability practices, even if some of them only do it in communication areas, e.g. publishing reports, and not sistematically. But it is still unclear if they are strategically adopting these practices or only by chance, accidentally (Baumgartner and Ebner, 2010). In that sense, considering the highlighted importance on understanding why and how companies integrate environmental sustainability into innovation initiatives (Dangelico and Pujari, 2010), it is important to question: *How has 'eco-innovation' been researched in business literature related to the drivers that boost the adoption by the companies? What are the drivers and motivations for the adoption of eco-innovation by companies? How could results from the literature help to define a conceptual framework of eco-innovation drivers and motivations?* Therefore, the purpose of this article is to systematically review the literature on drivers for adoption of eco-innovation in the business and management literature in order to perform a broadly theoretical assessment on the

subject. Furthermore, it is also our aim to draw propositions to be further tested over the conceptual model developed in this research.

Considering that this article brings a systematic review, its structure is slightly different from a traditional research article. Firstly we have a brief definition section (2), and in section 3 the method employed in this research is described. In section 4 the main results are described, and the conceptual model for studying the drivers of eco-innovation is proposed in section 5, when we present the discussion. In section 6 the main conclusions are drawn.

2. Theoretical Background

Sustainable development has its basis on the triple bottom line, that is, it can be addressed as the need for integration of environmental, economic and social performance, what is a recognized challenge for companies (Verghese and Lewis, 2007; Baumgartner and Ebner, 2010), raising the question: *how to do it?* The starting point for this article is to study eco-innovation along the lines of OECD concept (OECD, 2009), highlighting that this definition does not relate only to technologies, but broadly to new organisational methods, products, services and knowledge-oriented innovations that can also educate managers for adopting these practices (Antonioli et al., 2013).

Our study focuses on research papers dealing with companies that are adopting eco-innovations based on these broader premises: new products, processes or business models that will ultimately reduce an environmental burden. Companies must deal with environmental challenges to avoid damages in the environment and in their reputation, as a consequence. These challenges will be more or less complex, depending on the companies sector, activity (external factors) and the chosen strategy (internal factors). The innovation complexity will also depend on the different defies that the company must tackle (Ashford, 2002). Eco-innovation is a recognised win-win strategy when applied in a systematic, conscious and strategic way (Cainelli et al., 2012), integrating environmental approaches in most of company's internal and external decisions.

Therefore, companies must innovate for taking advantage of technological opportunities and market dynamics, but also to respond to changes in consumers' demand and lifestyles. A group of consumers, called citizen consumers (Spaargaren and Oosterveer, 2010, Verbeke at al., 2010), are now targeting companies that go beyond the technological advancements, but also take into account environmental and social issues that are sometimes overlooked. Therefore, the importance of including all stakeholders in the transition to an economy that integrates ecological concepts into innovation strategies and competitiveness is highlighted in the adoption of an eco-innovation strategy.

In addition to the multiple expressions to eco-innovation, given its multi and transdisciplinary approach (Boons and Lüdeke-Freund, 2013; Fagerberg, 2005; Santolaria et al., 2011), there are other ecological concepts in the literature and in practical use in companies operations or communications. The ecological concepts, in general, are means to achieve the goal (eco-innovation), are tools (strategic or otherwise) that can be used by companies to producing or processing eco-innovative products and, above all, to become themselves eco-innovative companies. Eco-innovation can be considered a paradigm shift, a change of philosophy related to innovation, and includes the environmental, economic and social pillars.

Companies can play a key role in the environmental performance of a country, given the impact of their activities on the environment. At the same time, consumers rely on companies to obtain the supply of eco-innovative options. In fact, even in the cases where the consumer does not know what he/she wants, companies can orientate the consumption according to its novelties and innovations presented to the market (Christensen et al., 2007).

For companies performing in a sustainable way, they must integrate such concerns into their business routines and their strategies, bringing positive effects for the society in the long term (Baumgartner and Ebner, 2010). For this reason, identifying the main drivers for adoption of eco-innovation points out as a main issue, first in the literature, and then empirically. Although some of the drivers for adoption of eco-innovation can overlap with innovation drivers, they will probably not influence the same variables with the same strength.

Eco-innovation is considered, in this research, as an output (not from a processual point of view, but as goal), which can be achieved by companies, encouraged by the government, demanded by society, as a way of contributing to sustainable development. Figure 1 aims to summarize the ideas discussed in this section. Sustainable development has its focus in meeting the need of the present, without compromising supply for future generations' needs (World Commission on Environment and Development - WCED, 1987). Innovation, in turn, supports these needs, aiming to the development of new products and processes by a combination of factors, knowledge, skills and resources (Fagerberg, 2005). Eco-innovation drives the scope towards a more sustainable development, in a way that, in addition to the innovation trait, its results should bring benefits for the environment (OECD, 2009). Thus, while innovation is neutral in relation to the direction of changes (aims at profits and market success), the additional attribute of eco-innovation is to reduce environmental burdens and to contribute to specific problematic areas, e.g. greenhouse effect, toxic impacts upon ecosystems and humans, loss of biodiversity, land and resources use (Rennings, 2000).
The needs for future generation, stated on the sustainable development definition (WECD, 1987) are dynamic, they will progress along the new challenges that society will face in the future. Therefore, the pressures exerted by internal or external stakeholders will be fed by the current scenario of sustainable development, and positively influence the adoption of eco-innovation, either directly, or through demanding more environmental awareness by companies. Both innovation and eco-innovation have market success as a goal, but eco-innovation suffers a significant influence from other factors for decreasing environmental burdens, such as from society, from the regulatory framework, and others. What are these influential factors, and how they drive the adoption of eco-innovation by companies is what we want to investigate in this paper.

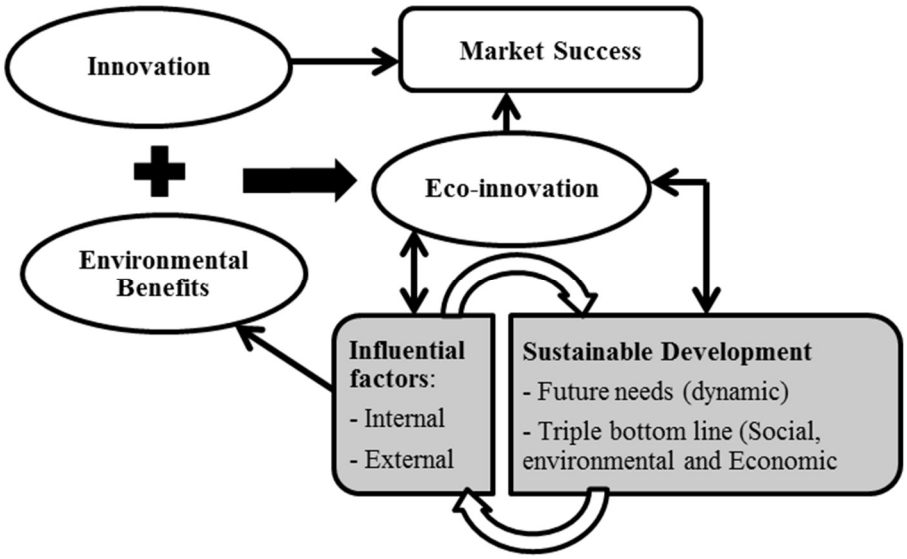


Figure 1. Eco-innovation dynamics – innovation, sustainable development and influential factors

3. Method (research protocol)

A systematic review was conducted to explore how has 'eco-innovation' been researched in business literature aiming at identifying the main drivers and motivations for the adoption of eco-innovation by the companies. Systematic literature review is a technique suitable to deal with a larger amount of information, and it contributes to answer questions about what works and what does not, in a practical point of view (Petticrew and Roberts, 2006).

The reason for applying a systematic review in business literature instead of mapping all the literature on eco-innovation is due to the specificity of the research question that aims to identify relevant drivers found exclusively in empirical papers. In other words, only drivers that actually led to the adoption of eco-innovation in companies were of interest for this research (Petticrew and Roberts, 2006).

The systematic review must adopt a scientific and strict process of literature search and assessment, in a way that the process of search can be easily understood and replicable (Tranfield et al., 2003). In this study, the systematic review followed the protocols outlined by Sampaio and Mancini (2006), Petticrew and Roberts (2006) and Tranfield et al. (2003), and certain methods were refined to adapt to social sciences research. Figure 2 shows the design of the research protocol. In this scheme, cells on the right side represent inclusion criteria and papers included in the given phases, while cells on the left side represent paper that did not match inclusion criteria and had to be taken out from the systematic review.

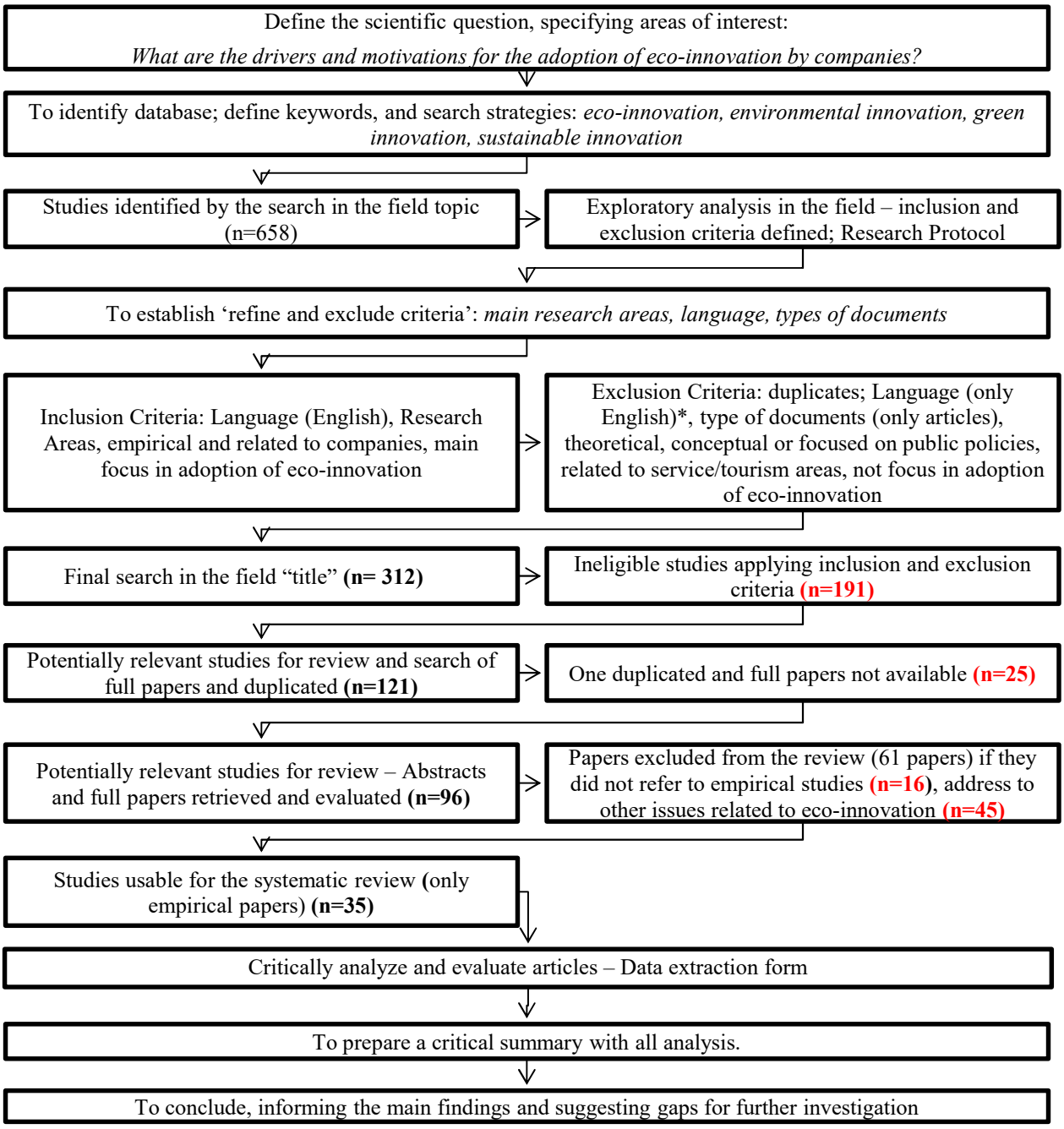


Figure 2. Systematic Review: Design of the research protocol [Source: Adapted from Petticrew and Roberts (2006) and Sampaio and Mancini (2007)]

Planning the review – refining inclusion and exclusion criteria

Determining keywords was one of the main steps for this work. Considering the restrained research question, keywords were selected accordingly, to keep searching process under strict focus on main drivers for adoption of eco-innovation. Since eco-innovation is a broad but new concept, and due to the relationship of this concept with sustainable development, we found out that similar concepts are usually used as synonyms in some papers. That is, 'green' and 'environmental', that comprise mainly

the environmental aspect of sustainable development and 'sustainable', that should comprise all aspects plus the word innovation, which mainly brings the economic aspect. Therefore, keywords used for this phase were: *eco-innovation* ("eco-innovat*" – Topic – 89 papers, 1996 - 2013); *sustainable innovation* ("sustainab* innovat*" – Topic – 132 papers, 2001 - 2013), *green innovation* (green innovat* - Title, 70 papers, 1971 - 2013) and *environmental innovation* ("environmental innovat*" – Topic – 132 papers, 1992 - 2013).

Some criteria were already defined since the beginning, e.g. inclusion of peer reviewed papers in English available in *ISI Web of Knowledge* database. Others were refined and selected after an exploratory search conducted in July 2013 for an accurate definition of all inclusion and exclusion criteria to enable the final search and analysis of this systematic review. ISI Web of Knowledge was chosen due to its emphasis on social sciences, and specifically in business literature, as endorsed by Dahlander and Gann (2010) and Agarwal and Hoetker (2007).

Within this exploratory search, we selected main areas of research, main journals where the concepts are studied, as well as we could analyse years of publication, identifying early publications and verifying how the progress was over the years. The first search was in the field "topic" to achieve a broad range of information, except for "green innovation", which was searched for in the field "title", otherwise we would have achieved more than 2,000 results.

Based on these results, final search was defined. Since this is a recent topic, the review was not restricted by date. As an inclusion criteria, we selected the following areas: Business Economics, Public Administration, Environmental Sciences Ecology, Operations Research Management Science, Science Technology Other Topics, Agriculture, Social Sciences other Topics, Food Science Technology.

Final Search and Analysis – conducting and reporting the review

Final search comprised only peer reviewed papers (in English) from the *ISI Web of Knowledge* database, within the above stated areas. The search for keywords eco-innovation ("eco-innovat*" – 36 papers), sustainable innovation ("sustainab* innovat*" – 25 papers), green innovation ("green innovat*" – 20 papers), and environmental innovation ("environmental innovat*" – 40 papers) was only for the title. Searching only in title was a strategy to find only papers that mainly focus in studying the adoption, motivations and drivers related to eco-innovation in companies.

To increase reliability, two researchers performed final search and results converged in 121 papers including one duplicated paper, totalizing 120 papers in this initial database. Given the main focus of this systematic review, full text must be analysed, so, the database remained with 96 full papers to be reviewed. First, abstracts were screened for relevance, and to assess which met the inclusion criteria (empirical studies, mainly focusing in studying drivers and motivations for adoption of eco-innovation in industries). Full papers were consulted when the abstract was not clearly meeting the inclusion or exclusion criteria.

Considering 61 papers excluded from analysis, 13 were not studies using primary data, among them we found theoretical studies, such as literature reviews, and not all of them had the focus on drivers for eco-innovation. We also excluded 3 papers that were not peer reviewed papers, for example, introductions to Special Issues. Other 45 papers were excluded, since they addressed other issues related to eco-innovation, instead of drivers for adoption of eco-innovation in companies, such as consumers' adoption; eco-innovation in service; analysis in a macro level, i.e. countries' adoption; green information technology, environmental policies, among others.

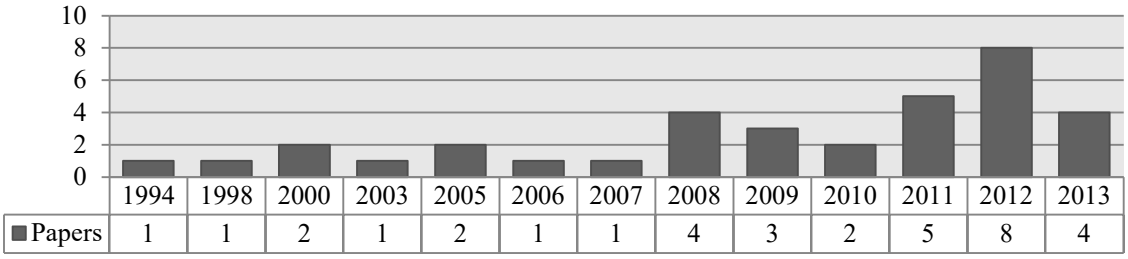
Finally, 35 full papers remained in the present systematic review, all empirical and with the main focus on researching relevant drivers for adoption of eco-innovation, meeting the aim of this article.

To organize the analysis and to achieve the main purpose of this article, it was important to fulfil a data-extraction form (Tranfield et al., 2003), including details of the information source (title, authors, journal, publication details), eco-innovation concept and criteria to select companies for empirical studies, methods and main findings, drivers and motivations for eco-innovation. The review template for the final sample includes the following items: i) Eco-innovation's concepts and approaches; ii) Methods and main findings; iii) Drivers and motivations for eco-innovation.

The importance of undertaking a systematic literature review is critical to further understand and assess a new research field (Seuring and Gold, 2012). The data collected through the systematic review was deeply analysed in order to achieve insights about the field and to identify important concepts and to draw conclusions about what the literature brings about this specific subject.

4. Results

Results indicate that there is a growing interest in the concept of eco-innovation. Since 2008, there is an increase in the number of papers (64% of papers were published after 2010 for the whole sample, and 54% of the 35 included in the SR, see Figure 3).



	1994	1998	2000	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013
Papers	1	1	2	1	2	1	1	4	3	2	5	8	4

Figure 3. Distribution of the papers included in the Systematic Review per year (from 1994-08/2013)

4.1. How has eco-innovation been studied in the literature?

4.1.1. Eco-innovation approach

In order to address the first research question "identifying and analysing how has 'eco-innovation' been researched in business literature related to the drivers that boost the adoption of eco-innovation by the companies", papers from this systematic review were also analysed in terms of different definitions of eco-innovation, as can be seen in Table 1.

In most papers, eco-innovation is defined similarly to OECD's concept. That is, the innovation (not only in product, but also in process and organisational methods), that brings benefits to the environment (or, at least, less burdens). It is important to highlight that companies' intentionality is out of question in this definition (see Table 1). Some papers also included the idea of improving performance, boosting product differentiation or adoption of green technologies. Eco-innovation was approached in a more holistic way in few cases, in a country level, to improve countries' environmental efficiency or developing green innovation systems.

Table 1. How eco-innovation has been conceptualized in business literature

Eco-innovation as….	References
… a broaden concept, using or based on OECD concept:	
• Eco-innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation and which results in a reduction of environmental risk, pollution and other negative impacts to relevant alternatives (Kemp and Pearson, 2008).	Antonioli et al. (2013); Beise and Rennings (2005); Buttol et al. (2012); Cainelli et al. (2012); De Marchi (2012); Horbach (2008); Horbach et al. (2012); Oltra and Jean (2009); Rennings et al. (2006); Theyel (2000)
• OECD (used in this paper)	Demirel and Kesidou (2011); Kesidou and Demirel (2012)
• Incremental approach, also aiming at elimination of the use/generation of hazardous substances and at environmental protection: eco-innovation is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management (Chen et al., 2006).	Berrone et al. (2013); Brunnermeier and Cohen (2003); Chang (2011); Chen (2008); Chen et al. (2012); Chiou et al. (2011); Eiadat et al. (2008); Gauthier and Wooldridge (2012); Huber (2008); Paraschiv et al. (2012); Tseng et al. (2013) Weng and Lin (2011)
… a way to improve environmental and/or social performance	Arnold and Hockerts (2011); Carrillo-Hermosilla et al. (2010); Chang and Chen (2013); Huang et al. (2009); Verghese and Lewis (2007)
… a mean to boost product differentiation	Azzone and Noci (1998)
... a way to improve eco-efficiency at the country level, companies are means for implementing tools to improve eco-innovation	Beise and Rennings (2005)
… a way to improve holistic green innovation systems or radical innovation	Bergquist and Soderholm (2005); Geffen and Rothenberg (2000)
… specific green technologies	Arnold and Hockerts (2011); Chappin et al., 2009); Qi et al. (2010)
… a response to environmental pressure	Green et al. (1994)

To complement the analysis of how eco-innovation has been studied in the literature, we also considered analysed how companies' database (sample) were selected in the reviewed papers. We have also evaluated how strict the studies were with the chosen sample in terms suitable eco-innovations for participating.

We found out case studies with companies that are traditionally aware of the importance to integrate environmental strategies into management (Arnold and Hockerts, 2011; Carrillo-Hermosilla et al., 2010; Geffen and Rothenberg, 2000; Tseng et al., 2013) or in adopting green technologies (Beise and Rennings, 2005; Bergquist and Soderholm, 2005; Chappin et al., 2009; Chen et al., 2012; Gauthier and Wooldridge, 2012; Green et al., 1994; Oltra and Jean, 2009; Verghese and Lewis, 2007). Several studies gathered data on national surveys (Antonioli et al., 2013; Cainelli et al., 2012; De Marchi, 2012; Demirel and Kesidou, 2011; Horbach, 2008; Horbach et al., 2012; Rennings et al., 2006) or had selected the companies from national or institutional databases created by environmental agencies (Berrone et al., 2013; Eiadat et al., 2008; Huber, 2008; Qi et al., 2010).

As proxies to select environmental cases, environmental patents were used in some cases (Berrone et al., 2013; Brunnermeier and Cohen, 2003; Oltra and Jean, 2009) or the sector (Eiadat et al., 2008; Geffen and Rothenberg, 2000; Chang, 2011, Chang and Chen, 2013; Chen, 2008; Chiou et al., 2011). Some cases were selected based on the size of the company (e.g. SMEs - Buttol et al., 2012; Paraschiv et al., 2012; Weng and Lin, 2011) or based on environmental certifications (Huang et al., 2009).

As it can be seen, due to the broaden definition of eco-innovation, it is necessary to find a strategy to select eco-innovative companies among the whole range of companies. Since the concept is still new, there is not a strict rule to select the cases, leading, eventually, to the selection of companies that only undertake a one-off action. Nevertheless, it is worth pointing out that this sample followed a pattern. Using institutional databases to select companies, eco-innovative companies were nominated according to their initiatives, such as the adoption of green technologies, environmental management systems and other environmental innovation activities that can vary from one sector to the other.

4.1.2. Methodological procedures and main findings

Related to the methodological procedures applied in the papers, **case studies were frequently used**. Arnold and Hockerts (2011), Berrone et al. (2013) and Chappin et al. (2009), for example, preferred to collect **longitudinal data** in their research. Usually, authors perform in-depth interviews and content analysis to interpret the data and find patterns for the results in these qualitative forms of research.

Quantitative research was also broadly applied, usually through **questionnaire survey**, as well as a **multi-method approach.** In this case, a qualitative and usually exploratory first phase is performed, followed by a descriptive research to test a model. Table 2 presents the methods applied in the papers of the sample as well as the sources.

Table 2. Authors, methods and Sources found in the selected papers

Authors	Method	Source
Survey		
Antonioli et al. (2013)	Survey	Research Policy
Cainelli et al. (2012)	Survey	Industry and Innovation
Chang (2011)	Survey	Journal of Business Ethics
Chen (2008)	Survey	Journal of Business Ethics
Chiou et al. (2011)	Survey	Transportation Research Part E
Eiadat et al. (2008)	Survey	Journal of World Business
Green et al. (1994)	Survey	Futures
Huang et al. (2009)	Survey	Journal of Management & Organization
Huber (2008)	Survey	Journal of Cleaner Production
Paraschiv et al. (2012)	Survey	Amfiteatru Economic
Qi et al. (2010)	Survey	Journal of Cleaner Production
Weng and Lin (2011)	Survey	African Journal of Business Management
Case Study		
Arnold and Hockerts (2011)	Case Study	Business Strategy and The Environment
Azzone and Noci (1998)	Case Study	Journal of Organizational Change Management
Beise and Rennings (2005)	Case Study	Ecological Economics
Bergquist and Soderholm (2005)	Case Study	Business History Review
Buttol et al. (2012)	Case Study	Clean Technologies and Environmental Policy
Carrillo-Hermosilla et al. (2010)	Case Study	Journal of Cleaner Production
Chappin et al. (2009)	Case Study	Environmental Science & Policy
Gauthier and Wooldridge (2012)	Case Study	Business Strategy and the Environment
Geffen and Rothenberg (2000)	Case Study	International Journal of Operations and Production Management
Verghese and Lewis (2007)	Case Study	International Journal of Production Research
Mixed Methods		
Chang and Chen (2013)	Questionnaire and public data	Management Decision
Chen et al. (2012)	Case study and Survey.	Management Decision
Horbach et al. (2012)	Panel data sources and Survey.	Ecological Economics
Rennings et al. (2006)	Case study and Survey.	Ecological Economics
Theyel (2000)	Questionnaire and interviews.	International Journal of Operations & Production Management
Panel Data - Secondary data		
Brunnermeier and Cohen (2003)	Panel data models	Journal of Environmental Economics and Management
De Marchi (2012)	Two-part logit model	Research Policy
Demirel and Kesidou (2011)	Econometric: Tobit model	Ecological Economics
Horbach (2008)	Econometric study	Research Policy
Kesidou and Demirel (2012)	Empirical analysis	Research Policy
Patents		
Oltra and Jean (2009)	Sectoral framework analysis	Technological Forecasting and Social Change
Berrone et al. (2013)	Analysis of secondary data: patents	Strategic Management Journal
Other methods		
Tseng et al. (2013)	Fuzzy set theory, entropy weights and Analytical network process	Journal of Cleaner Production

According to the main findings, only producing a "green" product can be a first step, but it is usually not enough to consider the company as entirely eco-innovative. To foster sustainability and apply eco-innovation in the strategy of the firm it is necessary to develop **a structured and long-term oriented management** of sustainability innovations (Arnold and Hockerts, 2011).

It is demonstrated in the literature the importance of **leading** (Arnold and Hockerts, 2011; Beise and Rennings, 2005; Gauthier and Wooldridge, 2012) and internationally competitive companies (Brunnermeier and Cohen, 2003) to pull the market towards a greener production. Companies should invest their resources in developing and cultivating the **internal factors** to aggregate more value for the firm (Chen et al., 2012). Nevertheless, environmental and innovative policy must be considered in an integrated way, so companies need to take into account the characteristics of the **technological environment** at the industry level, since it can be relevant at the company level (Oltra and Jean, 2009).

4.2. External and Internal drivers and motivations for eco-innovation: theoretical propositions

In this section, all the relevant drivers for adoption of eco-innovation that were identified on the empirical papers analysed in this systematic review are described, and propositions are made to move towards a conceptual framework about the subject.

4.2.1. External Factors

To respond to **constant changes in technology** (Geffen and Rothenberg, 2000) and to a shorter product's life cycle, companies must increase their investments in environmental innovations to enhance competitiveness. To justify financial investments to develop and implement innovative environmental solutions, there must have a prospect of expanding market share (Green et al., 1994; Azzone and Noci, 1998). In addition, since eco-innovation is embedded in a high level of uncertainty, and several resources are consumed throughout the process, the **government** can play a key role. In particular, public institutions are required to develop new campaigns aimed at increasing the level of the market environmental awareness (Azzone and Noci, 1998).

Analysing temporally the literature on the drivers and determinant factors for adoption of eco-innovation by companies, it is possible to notice that former papers, as Azzone and Noci (1998), were related to the adoption of environmental innovation as an "action to comply with the law and other regulations". Even if over the years other factors have been relevant to trigger eco-innovation, **regulatory pressures** still appear as a predominant driver in the literature (20 papers in this sample), as can be seen in Table 3. The degree of perceived pressure from regulatory stakeholders (Huang et al., 2009) and stricter regulations can boost eco-innovation and have been significant to stimulate Research and Development (R&D) policies (Bergquist and Soderholm, 2011; Huber, 2008) and to create leading markets in eco-innovation (Beise and Rennings, 2005).

Although the main focus in the literature is on regulation, many other factors also serve as *stimulus*, such as **knowledge bases, technological opportunities** as well as **demand's condition** (Paraschiv et al., 2012). That is, environmental innovation can be a reactive answer to the market (Oltra and Jean, 2009). Therefore, **normative pressure** and **market demand** are important external factors. Companies can face demands from suppliers, consumers, competitors, non-govermental organizations (NGOs), research centres, financing institutes on the adoption of eco-innovation (Arnold and Hockerts, 2011; Beise and Rennings, 2005; Gauthier and Wooldridge, 2012). These demands can be felt when investors and clients require information about firm's actions to mitigate hazardous burdens, as identified by Chen et al. (2012).

Demand factors, such as the adoption of Corporate Social Responsibility (CSR) and other customer requirements affect the decision of the firm to undertake eco-innovations (Kesidou and Demirel, 2012). Given the systemic and complex characteristic of eco-innovation, the relevance of

cooperation is also stressed (Carrillo-Hermosilla et al., 2010; Geffen and Rothenberg, 2000; Verghese and Lewis, 2007). Companies need to learn how to produce without burden the environment, so cooperation and interdependency between the firms (De Marchi, 2012; Horbach, 2008), customers, distributors, suppliers (Buttol et al., 2012; Green et al., 1994) and universities (Cainelli et al., 2012) improve the likelihood to eco-innovate.

Having that in mind, it is proposed to empirically investigate the influence of external factors, as **regulatory pressures**, that encompasses international, regional and local regulations (Chen et al., 2012; Eiadat et al., 2008); **normative pressures** and **market demand**, related to pressures from consumers' and societal demands, as well as other relevant stakeholders (Arundel and Kemp, 2011; Huang et al., 2009); **cooperation** not only with stakeholders, but also with external agencies, such as universities and research centres (De Marchi, 2012; Green et al., 1994) and **technology** environment at the sector level. Based on these findings, we draw our first proposition:

Proposition 1: External Factors to the company, that is (a) Regulatory requests, (b) Market demand, (c) cooperation and (d) higher development of industry's technology can boost the adoption of eco-innovation by individual companies.

4.2.2. Internal Factors

In addition to those external pressures, Arnold and Hockerts (2011) also studied companies' **internal factors** that can trigger environmental innovation and organizational development. Firm internal factors will induce the company to evaluate costs, benefits, and risks involved in the adoption of eco-innovations. In other words, companies seek for being more efficient causing less environmental burdens (Tseng et al., 2013), by developing higher R&D intensity (Berrone et al., 2013; De Marchi, 2012; Demirel & Kesidou, 2011), by acquiring new machinery, software (De Marchi, 2012) or simply upgrading it (Demirel & Kesidou, 2011).

Cost savings have been found as the most relevant motivation (Chappin et al., 2009; Demirel and Kesidou, 2011; Green et al., 1994; Horbach, 2008; Horbach et al., 2012), as well as the development of a more efficient organizational capabilities, organizational support and system-wide approach (Verghese and Lewis, 2007; Weng and Lin, 2011). Rennings et al. (2006) and Demirel and Kesidou (2011) reported a positive influence of Environmental Management System (EMS) on environmental innovations' adoption.

An efficient innovation management and encouragement for **"greening the supplier"** have been found as a positive influence on eco-innovation during the adoption process (Chiou et al., 2011; Tseng et al., 2013). Labelling and a good communication strategy (Arnold & Hockerts, 2011), adopting information and communication technologies (Cainelli; Mazzanti; Montresor, 2012), as well as adopting **environmental certification practices**, such as ISO 14001, represents an important starting point for the introduction of pro-active environmental practices (Azzone and Noci, 1998). In that sense, although certification practices can also be considered as an external normative pressure, they produce internal and significant effects to foster eco-innovation due to the changes and actions associated within the company.

It is important to integrate sustainability as an explicit goal in the design process, to succeed on the adoption of eco-innovation (Arnold and Hockerts, 2011). Evidence in the literature suggests that the construct '**managerial environmental concern**' is perhaps the strongest determinant of environmental innovation strategy (Chang, 2011; Eiadat et al., 2008; Qi et al., 2010). Environmental innovation strategy was found to be associated with firms' **positive business performance** since it can ensure internal efficiency (Eiadat et al., 2008; Tseng et al., 2013).

Chen et al. (2012) identified the following **internal origins** of environmental innovations: (1) **environmental leadership** (Paraschiv et al., 2012); (2) **environmental culture** (Chang and Chen, 2013; Paraschiv et al., 2012); and (3) **environmental capability**. Good environmental strategies to innovate (Berrone et al., 2013), Entrepreneurial Vision (Arnold and Hockerts, 2011), and perceived pressure from internal stakeholders increases the likelihood for a focal firm to adopt green technical innovations (Chang, 2011; Huang et al., 2009).

Human resources is a relevant driver for eco-innovation (Paraschiv et al., 2012). Developing internal platforms, networks and search for educational and sustainability programs (Arnold and Hockerts, 2011), and spend more on training can be important factors to succeed in an eco-innovation project (Cainelli et al., 2012; Green et al., 1994; Theyel, 2000; Weng and Lin, 2011).

To sum up, it is proposed that internal factor are related to **efficiency**, by cost reduction, equipment's update, investment in R&D or certifications (Green et al., 1994 and others, see Table 3); **environmental capability** and environmental managerial concerns, including environmental leadership (Chen et al., 2012; Eiadat et al., 2008); quality of **human resources**, including training and participation of sustainability programs (Green et al., 1994; Weng and Lin, 2011); and **environmental strategy**, including the culture of the firm. Therefore, our second proposition is presented:

Proposition 2: Internal Factors, that are (a) Efficiency, (b) Environmental capability, (c) Environmental managerial concern, (d) Human resources and (e) Environmental strategy can boost the adoption of eco-innovation by the companies.

4.2.3. Control Variables

In the systematic review, control variables were also identified. There is a positive influence on different patterns of firm's size (Berrone et al., 2013; Chen, 2008; De Marchi, 2012; Demirel and Kesidou, 2011), where bigger companies tend to develop and adopt more eco-innovation. Governmental support, in terms of financing, training or subsidise (De Marchi, 2012; Horbach, 2008; Weng and Lin, 2011) is positively associated with greater willingness to adopt eco-innovation. Sectorial differences (Berrone et al., 2013; De Marchi, 2012; Horbach, 2008) can also influence the adoption of eco-innovation in the sense that companies that belong to sector with higher emissions are more inclined to increase the adoption of eco-innovation. These findings lead to our third proposition:

Proposition 3: Factors such as (a) Company's size, (b) Sector, (c), and the presence of government support towards of eco-innovation can moderate the adoption of eco-innovation in the companies.

Table 3 presents a synthesis of the main relevant drivers for adoption of eco-innovation found in the systematic review.

Table 3. Drivers and motivations for the adoption of eco-innovation, their definitions and sources

Variable	Definition	Source
External Factors		
Regulatory pressures	Determined by governments, noncompliance with regulations can be very costly to the firm (Local, regional and international level)	Arnold and Hockerts (2011); Azzone and Noci (1998); Beise and Rennings (2005); Bergquist and Soderholm (2011); Berrone et al. (2013); Cainelli et al. (2012); Carrillo-Hermosilla et al. (2010); Chappin et al. (2009); Chen et al. (2012); Demirel and Kesidou (2011); Green et al. (1994); Horbach (2008); Horbach et al. (2012); Huang et al. (2009); Kesidou and Demirel (2012); Huber (2008); Oltra and Jean (2009); Paraschiv et al. (2012); Weng and Lin (2011); Qi et al. (2010)

Normative pressures	Related to the issue of legitimacy - organizations compare themselves with their peers and try to behave in accordance with standards or norms prevalent in the same institutional field. Market demand: Environmentalists, clients, suppliers' and societal demands.	Beise and Rennings (2005); Bergquist and Soderholm (2011); Berrone et al. (2013); Chen et al. (2012); Gauthier and Wooldridge (2012); Huanget al. (2009); Kesidou and Demirel (2012); Huber (2008); Oltra and Jean (2009); Paraschiv et al. (2012); Weng and Lin (2011)
Cooperation	Cooperation with suppliers, clients, competitors, consultants, universities, R&D public labs, technological centres	Bergquist and Soderholm (2011); Buttol et al. (2012); Cainelli et al. (2012); Carrillo-Hermosilla et al. (2010); De Marchi (2012); Geffen and Rothenberg (2000); Green et al. (1994); Horbach (2008); Huber (2008); Verghese and Lewis (2007)
Expanding market	Prospect of expanding market share can work as an incentive for companies to invest in eco-innovation	Green et al. (1994);
Technology	Characteristics of the technological environment at the industry level.	Oltra and Jean (2009); Geffen and Rothenberg (2000)
The role of governments	Government is required to develop new campaigns aimed at increasing the level of the market environmental awareness	Azzone and Noci (1998);
Internal Factors		
Efficiency	i) Cost Savings due to environmental improvements; ii) Equipment Upgrade motivations; iii) R&D investments and EMS Systems (Organizational Capability)	Bunnermeier and Cohen (2003); Berrone et al. (2013); Chappin et al. (2009); De Marchi(2012); Demirel and Kesidou (2011); Green et al. (1994); Horbach (2008); Horbach et al. (2012); Kesidou and Demirel (2012); Rennings et al. (2006); Theyel (2000); Tseng et al. (2013); Verghese and Lewis (2007); Weng and Lin (2011);
Adoption of certifications	Adoption of certifications, e.g., ISO 14001, that induce the adoption of an Environmental Management System (EMS), TQM	Arnold and Hockerts (2011); Azzone and Noci (1998); Demirel and Kesidou (2011);
Environmental managerial concerns	Top executives play an important role for adoption of eco-innovation and for integrating innovation and sustainability in companies' strategy.	Arnold and Hockerts (2011); Chang (2011); Eiadat et al. (2008); Qi et al. (2010); Tseng et al. (2013)
Environmental Leadership	A dynamic process in which one individual influences others to contribute to the achievement of environmental management and environmental innovations	Arnold and Hockerts (2011) Chen et al. (2012); Huang et al. (2009); Paraschiv et al. (2012)
Environmental Culture	A symbolic context about environmental management and environmental innovations within which interpretations guide behaviours and processes of members' sensemaking	Chang and Chen (2013); Chen et al. (2012); Paraschiv et al. (2012)
Environmental capability	A firm's abilities to integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations	Berrone et al. (2013); Chen (2008); Chen et al. (2012)
Human resources	Participation of employees in the innovation and training for employees, the company can count on high quality personnel	Arnold and Hockerts (2011); Cainelli et al. (2012); Green et al. (1994); Paraschiv et al. (2012); Theyel (2000); Weng and Lin (2011)
Performance	Measures: i) Sales growth; ii) market share; iii) Return on investment	Eiadat et al. (2008); Tseng et al. (2013)
Control Variables		
Firm's size	Structural characteristic that boosts green innovations	Berrone et al. (2013); Chen (2008); De Marchi (2012); Demirel and Kesidou (2011)
Public Financing	Public Financing is significant and positive in fostering eco-innovation introduction.	Bergquist and Soderholm (2011); De Marchi (2012); Horbach (2008); Weng and Lin (2011)
Sector	Sector influence according to its impact on the environment	Berrone et al. (2013); De Marchi (2012); Horbach (2008)

Source: authors

All those factors can influence the adoption of eco-innovation by the companies, and (positively) affect the performance, both in economic and environmental terms. Additionally, external factors can stimulate the increase in efficiency, organizational capability and other internal factors, leading the companies, for example, to an enhanced resource allocation. This can lead the adoption of eco-innovation. Therefore, we present our final propositions, leading to the conceptual model of this research:

Proposition 4: External Factors can induce (positively) the improvement of internal skills within the company, developing internal factors to boost the adoption of eco-innovation.

Proposition 5: The adoption of eco-innovation has a positive effect on company's performance.

5. Discussion: towards a conceptual model to eco-innovations

The needs foreseen on the sustainable development definition are dynamic and might change according to the current scenario, and that is one of the reasons why it is essential that sustainability and innovation must be run in conjunction. Eco-innovation is a recent topic, but the interest on the subject is increasing both under an academic point of view, as can be seen through the increased number of published papers on the topic, and also to practitioners, that are being constantly pressured to adopt eco-innovative practices.

Technological development and innovation have an important role on Western societies, and the awareness that innovation should also result in benefits for the environment and society in general is growing (Faucheux et al., 2006; Vollenbroek, 2002). Green competitiveness is also related with companies' needs to keep a good reputation with their stakeholders (Chen, 2008) and a way to increase competitiveness among companies and at a regional or country-level (Beise and Rennings, 2005; Bergquist and Soderholm, 2005; Geffen and Rothenberg, 2000; Kesidou and Demirel, 2012).

Considering this potential market for eco-innovation products, as well as the possibilities for companies increasing their efficiency through the adoption of environmental process or new organisational methods, understand how eco-innovation has been studied in the business literature was critical. After a deep analysis in the data collected in the systematic review, aiming at assessing and developing the knowledge base about drivers and motivations for adoption of eco-innovation (Seuring and Gold, 2012), the conceptual model was drawn. Although there are several other factors in the literature, our emphasis for the conceptual model stated in Figure 4 is on the factors that were found relevant on previous research in business literature, according to section 4.2. In general terms, our model proposes that external factors impact on internal factors and both on the adoption of eco-innovations, leading to a positive performance for companies.

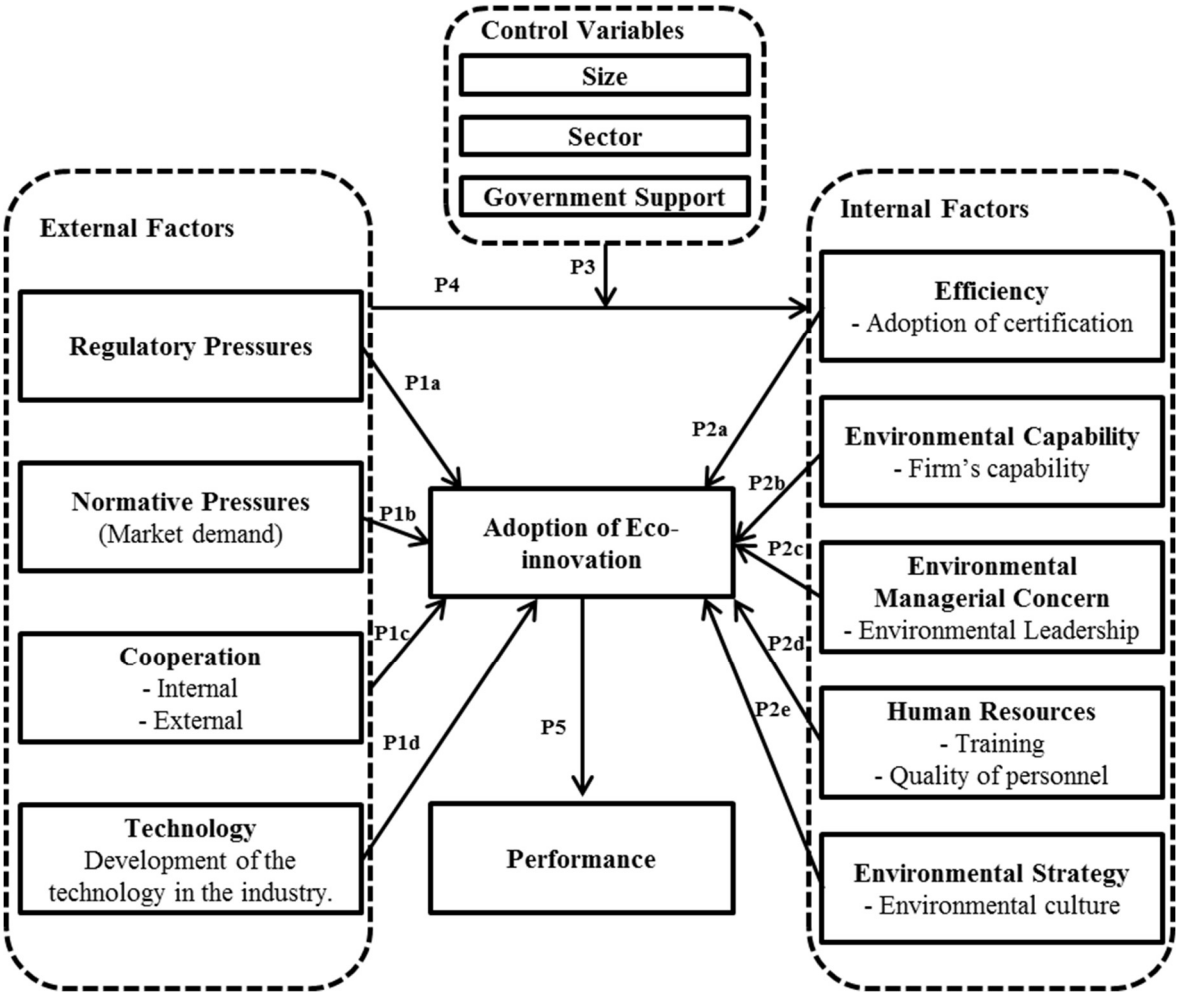


Figure 4. Conceptual Model

The model can contribute to better understand the dynamic of adoption of eco-innovation and serve as a guide towards a more sustainable behaviour from companies, which usually face trade-offs when starting to invest in a new market. Understanding what motivated them can help policy makers to guide and predict company's behaviour and develop tools to induce a more environmental management. It is a brand new topic for research and the conceptual model warrants empirical research and validation.

According to the main findings, to raise sustainability and apply eco-innovation in the strategy of the company, high long-term commitment is necessary, as well as an intended strategy, and a clear aim to develop more sustainable process (Baumgartner, 2011; Baumgartner and Ebner, 2010). Drivers for the adoption of eco-innovation (see section 4.2) relates to factors that affects directly or indirectly, internal or externally, the companies. Surprisingly these results can bring a contradictory feature to the concept. Although it is stimulated more integration of eco-innovation as the core business, or as a goal to be achieved through an integrative scheme that should involve all the areas within the company, the broaden characteristic of the concept leads to the fact that punctual actions were considered as eco-innovations.

The importance of this study is due to the fact that besides the pressure that exist from society and government for a production with less impact on the environment, the desire to use "green" is

increasing among consumers who rely on companies to obtain the supply of eco-innovative options. Companies can react to this pressure or anticipate their action by acting proactively due to the internal factors that envision the need for more environmental sustainability in the innovation process.

Global resource scarcity and environmental degradation influence the growth of reputational and regulatory pressures (European Commission and the United Nations Environment Programme, 2013), making companies face both challenges and opportunities. Resource efficiency (using the earth's resources in a sustainable manner while minimizing impacts on the environment; creating more with less) and eco-innovation (mainstreaming sustainability at the strategic level, throughout all the core operations of a company) are business approaches which can help businesses to tackle this issues and increase their ability to access new markets, enhance product quality and technical capacity, and increase profitability. In sum, the eco-innovation approach can provide a win-win solution to foster economic competitiveness and sustainability.

6. Conclusions

This study drew propositions for further empirical research on eco-innovation. Academic research has an important role to enhancing sustainability and innovation orientation, providing decision makers, in a managerial and policy perspective, with tools that can be helpful during the process of implementation and adaptation to new strategies. We have identified how has eco-innovation been researched in business literature related to the drivers that impact the adoption by the companies and emphasized motivations for the implementation of eco-innovation

In relation to the drivers and motivations for the adoption of eco-innovation, regulation is the most cited factor, as well as normative pressures and the need for efficiency (cost saving, for example). In other words, although companies are starting to develop eco-innovations, the motivations are still very much oriented towards compliance with the standards, much more than motivated by truly sustainable goals. Such result also highlights the need for more education for sustainability in the business world, as well as for consumers. If there is a market and governmental incentives for companies to create and develop more eco-innovative products, green market can turn into a very attractive alternative for many companies.

The findings of this paper are aligned with some previous studies and contributes to the advance of this debate. Gonzalez (2005) studied the pulp and paper sector and affirms that external and internal factors might affect the adoption of clean production. Our findings also pointed out the importance of both sectors, but we expanded through the analysis of papers with empirical data from several sectors and with the concept of eco-innovation, which differs from clean technology. The latter means change in production process to reduce environmental impact while the former is a wider concept, a change of philosophy that relates to innovation and include the three pillars of SD (economic, environmental and social). In this sense, our results also evolve from the study by Gonzalez (2009), who proposes an environmental technological change agenda, a concept distinguished from his previous work (clean production) since it pays attention to the stages of invention, innovation and diffusion. In that study, Gonzalez (2009) identifies as main drivers the technology and environmental policies and regulation (external factors). Regarding the use of eco-innovation concept, Carrillo-Hermosilla et al (2010) carried out case studies to identify the diversity of eco-innovations and conclude pointing out the role of public policy to boost adoption of eco-innovation. Our findings recognise the role of policy and regulation as an external driver but also add bringing up the internal factors with same importance for companies adopting eco-innovation.

By moving from an understanding of what are the main drivers for adoption of eco-innovation, it was possible to advance theoretically in the knowledge of the field and to develop a conceptual model. In this sense, this article contributes pointing out the internal factors that companies can manage in order

to fully adopt eco-innovation. While companies have minimum control of external factors, they can go beyond mere compliance when adhering to internal factors (for instance environmental capability, environmental managerial concern, human resources and environmental strategy). These factors, identified in the business literature and part of our conceptual model, can lead companies to change to a more sustainable performance.

Besides this theoretical contribution to be expanded in further research in eco-innovation, the internal factors also bring managerial implications of this study. Managers that are willing to adopt eco-innovation have these factors identified to support a change. Although the importance to include eco-innovation as a core competence of the company was also emphasized, articles analysed in this systematic review do not always considered explicitly this aspect when selecting companies for the empirical studies, thus it is a limitation of our research.

As suggestions for future research, this topic can be further investigated through a meta-analysis, with a broader scope and search, including other relevant databases, such as Elsevier's Scopus. Furthermore, the conceptual model can be statistically validated as well as the relationships found with companies from different sectors and countries, in order to understand their main characteristics and countries' similarities and differences. Understanding how the adoption of eco-innovation is boosted by a willingness to contribute to the achievement of sustainable development, or, better posed if sustainable development is achieved by the adoption of eco-innovation is an important point to be investigated.

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