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"Drivers for adoption of eco-innovation and enhancement of food companies' environmental performance"

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For a better world, with more equality, peace, democracy,
sustainable development and health food for all.

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“Resource consumption is the key focus of eco-innovation observatory because the overuse of global resources is linked to the most prominent environmental problems and social inequalities today.”

Eco-innovation observatory

Drivers para adoção de eco-inovação e melhoria do desempenho ambiental de empresas brasileiras do setor de alimentos

Resumo expandido

Depois de centenas de milhares de anos, a população mundial alcançou a marca de 1 bilhão de pessoas, para logo em seguida, em apenas 200 anos crescer cerca de sete vezes mais, sendo esperados a marca de nove ou dez bilhões para o ano de 2050 (UNFPA, 2015). Esse crescimento intenso trouxe uma maior complexidade nas estruturas sociais e ambientais, trazendo importantes questões: Como será possível manter todas essas pessoas? Como alimentá-las? Como frear esse irrestrito uso de recursos?

A produção e consumo de alimentos exerce um importante papel para dar suporte à população, mas ao mesmo tempo é um dos mais importantes elementos pressionando o meio ambiente (FAO, 2015). Para alcançarmos um desenvolvimento mais sustentável, é preciso haver mudanças drásticas nos padrões de produção e consumo, ou seja, mudanças na forma como os alimentos são produzidos, processados, transportados e consumidos são indispensáveis (Del Río, 2005; FAO, 2015).

Expansão e mudanças econômicas rumo a novos métodos de produção são diretamente relacionados à inovação. Porém, crescimento econômico está geralmente relacionado a problemas ambientais, que junto com o aumento da consciência ambiental dos consumidores e pressões sociais e governamentais, forçam as empresas a pensar em maneiras de reduzir seus impactos ambientais (Bocken *et al*., 2011).

Para combater problemas relacionados ao desempenho (Ettlie, 1983) ou ameaças devido a problemas ambientais (Horbach, 2008; Dangelico & Pujari, 2010), muitas vezes, as empresas optam por estratégias de adoção de inovações ou, especificamente no contexto ambiental, eco-inovações.

A Organização para a Cooperação e Desenvolvimento Econômico (OECD, do inglês *Organisation for Economic Co-operation and Development*) definiu eco-inovação como "a criação de produtos (bens e serviços), processos, métodos de *marketing*, estruturas organizacionais e arranjos institucionais novos ou significativamente melhorados, que - com ou sem intenção - levam a melhorias ambientais em comparação com outras alternativas relevantes" (OECD, 2009, p. 2).

Assim como a abordagem da inovação, a eco-inovação é multi e transdisciplinar (Fagerberg, 2005; Santolaria *et al*., 2011; Boons & Lüdeke-Freund, 2013), o que acaba levando à existência de uma série de termos relacionados – inovações sustentáveis, inovações ambientais, inovações "verdes" e eco-inovações, sendo esta última a principal expressão adotada neste trabalho.

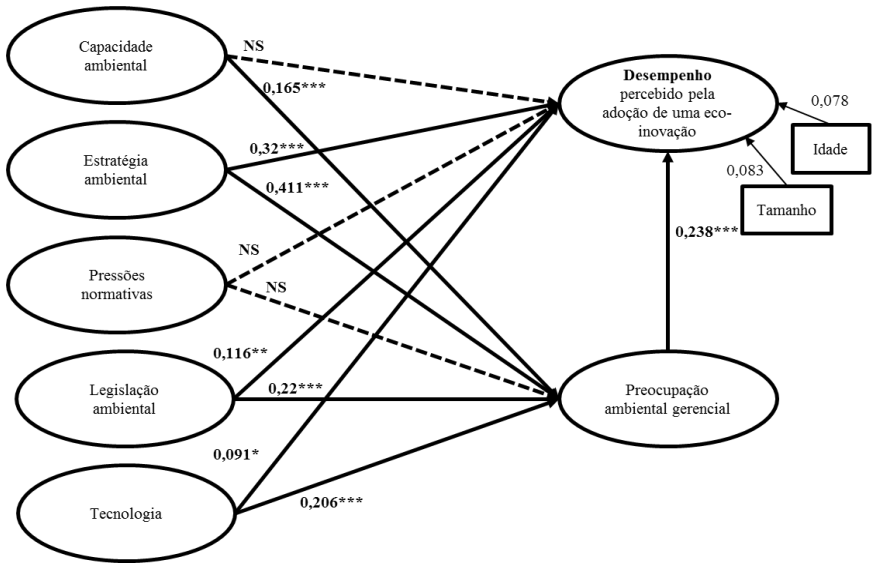
Esse estudo visa responder às seguintes questões de pesquisa: Quais são as condições para integrar inovação e sustentabilidade no setor de alimentos? Ou seja, quais são os *drivers* que influenciam a adoção de eco-inovação e melhoria do desempenho ambiental das empresas brasileiras de alimentos? O objetivo geral foi identificar como as empresas brasileiras de alimentos integram inovação e sustentabilidade, verificando quais são os *drivers* que influenciam a adoção de eco-inovação e melhoria do desempenho ambiental. Os objetivos específicos são: i) identificar na literatura os principais *drivers* para adoção de eco-inovação; ii) investigar e validar esses drivers como construtos que influenciam a adoção de eco-inovação e melhoria do desempenho; iii) propor um *framework* para analisar *drivers* internos e externos que influenciam a adoção de eco-inovação; iv) identificar o perfil das empresas eco-inovadoras; v) verificar a influência dos *drivers* na melhoria do desempenho ambiental, e vi) verificar o papel da preocupação gerencial ambiental na adoção de eco-inovação e na mediação da relação dos *drivers* com a melhoria do desempenho ambiental.

Para realizar essa pesquisa e atingir os objetivos estabelecidos, diferentes técnicas de pesquisa foram realizadas e, dessa forma, compuseram os procedimentos metodológicos. Tais procedimentos estão detalhados conforme as etapas de trabalho necessárias para o atingimento do objetivo geral. Primeiro, foi realizado o desenvolvimento teórico e conceitual, com uma ampla revisão de literatura, além de uma revisão sistemática para identificar os principais *drivers* para a adoção de eco-inovações nas empresas. A seguir, uma pesquisa exploratória foi realizada para validação e desenvolvimento do modelo de análise final. Por fim, foi realizada uma *survey* com empresas brasileiras do setor de alimentos. A análise dos dados dessa fase quantitativa foi realizada por meio de modelagem de equações estruturais.

Os resultados empíricos deste estudo sobre os drivers para a adoção de eco-inovação, com base em um conjunto de dados final com 525 empresas de alimentos do Brasil, revelam alguns novos e relevantes *insights*. Em termos de influência dos *drivers* para melhoria do desempenho ambiental das empresas de alimentos do Brasil, verificou-se que o desempenho ambiental é diretamente afetado pela estratégia ambiental, legislações ambientais, preocupação gerencial ambiental, e de maneira muito fraca, tanto em magnitude quanto em importância, pela tecnologia. A preocupação ambiental gerencial torna-se um conceito central neste estudo, tanto como um importante fator de influência direta para aumentar o desempenho das empresas devido à adoção de uma eco-inovação, quanto como um mediador de outros fatores importantes. Preocupação gerencial ambiental é influenciado positivamente pela capacidade ambiental, a estratégia ambiental, legislação ambiental, e pela tecnologia.

Na figura abaixo, é apresentado o modelo estrutural final.

Modelo estrutural final



As linhas sólidas são caminhos significativos, linhas pontilhadas são caminhos não significativos
***p<0,001 **p<0,05 *p<0,1

Compreender o que motivou a adoção de eco-inovação pelas empresas pode ajudar os formuladores de políticas públicas a orientar e prever o comportamento das empresas e desenvolver ferramentas para influenciar uma gestão mais ambiental. Tal resultado também destaca a necessidade de mais educação para a sustentabilidade no mundo dos negócios, bem como para os consumidores. Além disso, o papel fundamental da preocupação ambiental gerencial para aumentar a adoção de eco-inovação e aumentar

a desempenho ambiental amplia a consciência sobre a importância de incluir ainda mais a sustentabilidade no currículo escolas de administração.

Esta tese trouxe uma abordagem inovadora, com o apoio de literatura robusta através de revisão sistemática, pesquisa exploratória e teste de hipóteses com modelagem de equações estruturais. Isto permitiu desenvolver um modelo conceitual abrangente, reunindo e investigando todos os fatores relevantes na literatura e usando esses fatores com parcimônia no modelo final para a investigação empírica. Os *drivers* selecionados foram previamente testados na literatura, mas não como um todo e para investigar a sua influência sobre o desempenho ambiental.

O teste empírico do modelo com todos os fatores selecionados, por conseguinte, foi testado com uma amostra representativa. O ajuste do modelo foi adequado, bem como as medidas usadas, sendo o modelo considerado como significativo e deve ser testado com diferentes setores, uma vez que os pressupostos teóricos não estão restritos a um determinado setor. Portanto, com um quadro teórico robusto, foi possível utilizar a análise de confirmação proposta.

Abstract

Although the importance of innovation and sustainability for industries is evident, apparently in the food sector those concepts are being considered separately. The Organization for Economic Co-operation and Development (OECD) defines eco-innovation as "the development of products, 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). The main goal of this PhD Thesis is to identify how Brazilian food companies integrate innovation and sustainability, verifying what are the conditions (drivers) for adoption of eco-innovation and enhancement of environmental performance due to this action. The method applied included the following phases: In addition to an extensive literature review, that permeates the whole study, a systematic review in the literature was applied to identify main constructs that could be part of the final conceptual model. An exploratory research included in-depth interviews with eco-innovative food companies' representatives, and validation process for data collection was crucial for data collection instrument development. To analyse the descriptive phase, structural equation modelling was applied. The aim was to verify empirical causal relationships among given drivers for adoption of eco-innovation and the enhancement of performance in Brazilian food companies. The quantitative data from this stage was analysed with SPSS (Univariate statistics) and Amos (Multivariate statistics - SEM). The empirical results from this study shed light on the drivers of eco-innovation based on a final dataset with 525 Brazilian food companies, revealing some relevant new insights. In terms of the influence of drivers to enhance the environmental performance of Brazilian food companies, it was found out that environmental performance is directly affected by environmental strategy, environmental regulations, environmental managerial concern, and very weakly, both in magnitude and in significance, by technology. Environmental managerial concern become a central concept in this study, both as an important direct influential factor for increasing companies` performance due to the adoption of an eco-innovation, and as a mediator of other important factors. Environmental managerial concern is positively influenced by environmental capability, environmental strategy, environmental regulation, and by technology. Practical implications include the importance of understanding what motivated companies to eco-innovate to help policy makers to guide and predict company's behaviour and develop tools to induce a more environmental management. Such result also highlights the need for more education for sustainability in the business world, as well as for consumers. In addition, the key role of environmental management concern to boost adoption of eco-innovation and increase environmental performance raise awareness on the importance of further include sustainability in business schools' curriculum. This thesis brought an innovative approach, with robust literature support via systematic review, exploratory research and test of hypotheses with structural equation modelling. This allowed to develop a comprehensive conceptual model, gathering and investigating all relevant factors in the literature, and using those factors with parsimony in the final model for the empirical investigation. The selected drivers were previously tested in the literature but not as a whole and to investigate its influence on environmental performance. The empirical test of the model with all the selected factors was therefore tested with a representative sample. The model fit was adequate, as well as measures used, being the model considered as meaningful and should be tested with different sectors, since theoretical assumptions are not restricted to a given sector. Therefore, with a robust theoretical framework, it was possible to use the proposed confirmatory analysis.

List of Illustrations

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List of acronyms

OECD - The Organisation for Economic Co-operation and Development

WCDE - World Commission on Environment and Development

FAO - The Food and Agriculture Organization of the United Nations

GHG - Greenhouse Gas

NGOs - Non-Governmental Organizations

CSR - Corporate Social Responsibility

EMS - Environmental Management System

R&D - Resources and Development

CMIN/DF - The ratio of $\chi 2$ to degrees of freedom

NFI - The Bentler and Bonnet normed fit index

NNFI - The Bentler and Bonnet non-normed fit index

CFI - The Bentler comparative fit index

RMSEA - The Root Mean Square Error of Approximation

GFI - Goodness of Fit index

AGFI - Adjusted Goodness of Fit index

PNFI - Parsimonious Normed Fit Index

PCFI - Parsimony comparative fit index

SEM – Structural equation modelling

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1. INTRODUCTION

"Human beings are at the centre of concern for sustainable development. They are entitled to a healthy and productive life in harmony with nature."

The first principle of the 1992 Rio Declaration (UN, 1992)

After hundreds of thousands of years, population growth has reached the mark of 1 billion people, to just after that, in around 200 years, increase this mark by 7 times. The world is expected to have around 9 or 10 billion people for the year of 2050 (UNFPA, 2015). This intense growth has come along with more complex structures, both socially and environmentally, bringing some important concerns related to the questions: How will we support all these people? How to feed everyone? How to break an unrestrained use of resources?

Production and consumption of food play a key role to support inhabitants, but at the same time is one of the most important elements that pressurize the environment (FAO, 2015). Moving towards a more sustainable development (SD) depends on drastic changes in production and consumption patterns, that is, vigorous changes in the ways food is produced, processed, transported and consumed are indispensable (Del Río, 2005; FAO, 2015).

Companies are raising awareness on the responsibility for their impact to the environment, and are taking into consideration social and environmental concerns when developing new products, process or organizational methods (Medeiros, Ribeiro, & Cortimiglia, 2014). Environmental strategy is gradually becoming a recognised win-win strategy in business replacing the traditional reputation of being an approach that contradicts aims of growth, competitiveness and profitability (Andersen, 2004; Porter & Van Der Linde, 1995). That is, it is not only a cost that must be taken to comply with social and government pressures (Bocken *et al.*, 2011).

Economic expansion and economic change (towards new production method) is directly dependent on innovation. Nevertheless, economic growth is usually associated with environmental damages, and together with increasing consumer awareness, as well as social and government pressures, companies are being forced to reduce their

environmental impact (Bocken *et al.*, 2011). In an attempt to be socially responsible, companies' concerns in relation to their role in society is growing and environmental concerns for innovation are being incorporated (Díaz-García, González-Moreno, & Sáez-Martínez, 2015). Industrial society is trying to establish alternatives that mitigate environmental risks derived from its activities (Korhonen, 2001).

Agriculture and food sector can play an important role to face problems related to economic crisis, mostly in developing countries (FAO, 2014). Renovating the agricultural sector in a sustainable way is a required challenge for sectorial institutions, companies and government in order to turn feasible to feed the growing world population in a limited amount of physical territory and natural resources (FAO, 2014).

Accordingly, environmental innovation is highly important for the food sector given its high environmental impact and level of emissions (Demirel & Kesidou, 2011). Although its vulnerability to climate incidents, land sectors are responsible for 30% of greenhouse gas (GHG) emissions, and crop and livestock production emissions represent half of the methane and two-thirds of the nitrous oxide emitted into the atmosphere (FAO, 2014).

Within this context, the concept of eco-innovation arises, not only from a theoretical, but also from a practical and applied point of view. 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 & Lüdeke-Freund, 2013; Fagerberg, 2005; Santolaria, Oliver-Solà, Gasol, Morales-Pinzón, & Rieradevall, 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 study.

Integrating innovations and sustainability has been a topic of growing interest among scholars (Gauthier & Wooldridge, 2012). OECD's definition of eco-innovation is one of the most used, and can be understood as an innovation that improves environmental performance (Carrillo-Hermosilla, Del Río, & Könnölä, 2010). It is clear that companies need to adopt cleaner technologies and work practices, different of those currently in practice in order to improve their environmental performance (Ashford, 2002). Acting in

that way, companies will be more efficient and therefore, increase their performance (Weng, Chen, & Chen, 2015). That is, eco-innovating and improving environmental performance seems to be complementary concepts (Eiadat, Kelly, Roche, & Eyadat, 2008). Environmental performance is also related to companies` proactive initiatives that overcome mere compliance with mandatory issues (Chen, Tang, Jin, Li, & Paillé, 2014).

Sustainability in this study is defined by the World Commission on Environment and Development, that is, "a development that meets the needs of the present without compromising the ability of future generation to meet their own needs" (WCED, 1987). 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).

Companies play a key role and the food sector brings interesting elements to go deeply in the study of eco-innovation for several reasons. The food industry is more prone to add value to the products through differentiation and market orientation, and to influence consumer's demand for safety and healthy food, animal welfare, environmental issues, among others (Grunert *et al.*, 2005, Vieira, De Barcellos, Hoppe, & Bittencourt, 2013). However, eco-innovation in agriculture and in the food sector can be a complex issue. The complexity is because technological changes can turn the system intricate and due to the difficulties raised when one wants to measure the level of sustainability (Lowe, Phillipson, & Lee, 2008). The challenge also involves the ability of encompassing all links of the food chain, from 'cradle to grave' (Ohmart, 2008). In addition to this, it is not clear for the food companies what is sustainability, why to adopt and how to include environmental issues in an economic and profitable strategy (Santini, Cavicchi, & Casini, 2013).

1.1 PROBLEM STATEMENT AND RELEVANCE

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.

It is clear that companies are increasing the adoption of sustainability practices, even if some of them only in communication areas, e.g. publishing reports, and not as a whole. But it is still unclear if they are strategically adopting these practices or only by chance, accidentally (Baumgartner & Ebner, 2010). In that sense, the importance on understanding why and how companies integrate environmental sustainability into innovation initiatives is highlighted (Dangelico & Pujari, 2010).

Although the importance of innovation and sustainability for industries is evident, apparently in the food sector those concepts are being considered separately. There is a lack of studying eco-innovations in the food sector and consequently this is an area for extending research. 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 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.

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.

Eco-innovation is the main concept in this study and is considered as an end goal that can be achieved by companies, demanded by society, as a way to contribute to sustainable development. Eco-innovation can be considered as a paradigm shift related to innovation and including economic, social and environmental pillar. Green

competitiveness goes beyond consumerism, and is associated with companies' need to keep a good reputation (Andersen, 2004).

Technological development and innovation play a significant role in many global economies and benefits received in terms of competitiveness and economic growth from these factors are still very valued. However, there is growing knowledge that innovation can not only result in economic strength, but also in better quality for the environment and for society in general. Technological competition is often tough in various industries, due in large part to the discovery of new environmental and social problems, the emergence of public and private policies for sustainable development and current regulations (Faucheux, Hue, & Nicolaï, 2006; Vollenbroek, 2002).

In Brazil, it is estimated that in 2030 population will reach 223 million, with more urbanization (Euromonitor, 2015). Brazil is one of the major five emerging economies, the largest economy in Latin America and seventh in the world, being considered by OECD as a key partnership and an active and committed member for agricultural and food initiatives and assessments (OECD, 2014). Over the past two decades and with the economic and social improvements in Brazil, agriculture and agro-processing sectors have presented an impressive growth (OECD, 2015).

Food and agricultural sector are key industries for Brazilian's further development given its weight in the national economy and the resource potential that can be exploited (OECD, 2015). Brazilian food sector's net revenue has grown from 2000 to 2014 from R$ 91.1 to R$ 529.6 billion (ABIA, 2015). This sector comprises around 30 thousand companies and employs 1.66 million people.

Food security is directly related to healthiness and productiveness, and food chains must be managed in a way that respects social, environmental and economic principles (FAO, 2012). Brazil has to reconcile agricultural growth with two societal objectives, that is, (1) to warrant that growth is environmentally sustainable and (2) that growth is in line with structural adjustments to support small farmers, with poverty reduction (OECD, 2015).

In that sense, innovation is one of key areas for building capacity for enabling countries and nations to move towards sustainable development in the food sector (FAO, 2012). Therefore, there is a need to study companies that are already applying these concepts of innovation and sustainability in their strategies, to envision what has driven these benchmarking companies and to plan further actions to stimulate more initiatives in that direction.

1.2 RESEARCH QUESTION

This study aims at answering the following question: What are the drivers for Brazilian food companies to adopt eco-innovations and increase their environmental performance?

1.3 MAIN GOAL

To identify what are the relevant drivers for adoption of eco-innovation and enhancement of environmental performance.

1.4 SPECIFIC GOALS

a) To identify in the literature main drivers and determinants for adoption of eco-innovation.
b) To investigate and validate these drivers as constructs that influence adoption of eco-innovation and enhancement of performance.
c) To propose a framework for assessing influence of external and internal drivers for adoption of eco-innovation in Brazilian food sector.
d) To identify the profile of Brazilian food companies that adopt eco-innovation.
e) To verify the influence of determinant drivers on the enhancement of environmental performance.
f) To verify the role of an environmental entrepreneur on the adoption of eco-innovation and on the mediation of the relation between drivers and environmental performance.

1.5 OUTLINE

This study is organised as follows. Chapter 1 presents an introduction to the subject, in which the research background is briefly described and the research problem is presented. The relevance of this study, the research questions and the goals that guide this research are also described.

Chapter 2 brings the research background, in which a thorough literature review is performed. The following subjects are discussed: sustainable development, innovation,

types of innovation, eco-innovation, relationship among sustainable development, innovation and eco-innovation, and finally, drivers for adoption of eco-innovation.

In chapter 3, the conceptual model is drawn and hypotheses are stated. Method is presented on Chapter 4, with the following sections: theoretical background and systematic review, exploratory research, descriptive research, data preparation and data analysis. Results and conclusions follows on Chapters 5 and 6, respectively.

2. RESEARCH BACKGROUND

"It is important not only that we know what we know, but that we know what we do not know."
Lao-Tze, Chinese Philosopher

In this chapter, literature review is performed and it is organised as follows. First, sustainable development literature is brought (section 2.1), followed by innovation and types of innovation (sections 2.2 and 2.2.1). Eco-innovation literature, main definitions and theoretical foundation are presented in sections 2.3, 2.3.1, and 2.3.2, respectively. Then, the relationship among sustainable development, innovation and eco-innovation is discussed in section 2.4. And finally, in section 2.5, main drivers for adoption of eco-innovation are outlined.

2.1 SUSTAINABLE DEVELOPMENT

Mainly after World War II, interrelationship among society, companies and physical environment started to be discussed, mostly focusing in criticizing social and environmental consequences caused by developmentalism and economic growth. The most known and accepted sustainable development concept was written in 1987 on *Brundtland's* Report.

Sustainable development was defined as the development that meets the need of the present without compromising the capacity of providing future generations (World Commission on Environment and Development - WCED, 1987). Nevertheless, there is no consensus on drawing what are these needs. Some authors' approaches include its dynamic characteristics (Newman, 2005; Hellström, 2007; Vollenbroek, 2002). Others address under the aspect of different perspectives and concerns, what directly influence perception on what are the latent needs (Banerjee, 2003; Wals & Schwarzin, 2012).

Due to an increasing level of public concern and environmental regulations, companies are raising awareness with socio-environmental issues (Banerjee, 2001, 2003). That is, regulatory pressures (macro level) impact public opinion, what ends up shaping companies behaviour (micro level).

Sustainable development requires an economic and social progressive transformation (WCED, 1987). Considering this, sustainable development must be a continuous process of change, which may be related to system innovations that require an integrated redesign of products, lifestyle, process and structure. In that sense, Wals and Schwarzin (2012) worries include finding a way to include people, organizations and communities in these transitions, while recognising all benefits of doing things in a more sustainable way.

Sustainable development also means to put together growing concerns with environment and socio-economic issues (Hopwood, Mellor, & O'Brien, 2005). Economics must be a function of society and environment, not the other way around. Thus, sustainable development should be based on the relationship between environment and society, with feedbacks' cycles for both sides, in which social and environmental equality are fundamental ideals (Hopwood, Mellor, & O'Brien, 2005).

During 1990s two great movements took emphasis on sustainable development discussions, one concerned with how to measure sustainable development, and the other with economic growth boundaries towards sustainable development (Robinson, 2004). Therefore, there is an attempt to close this gap between ideas and practical/applicable issues, to turn the theoretical concept into pro-sustainable development actions, grounded on environmental, economic and social pillar. Nevertheless, this is a great challenge since our society and companies are, traditionally driven by the economic pillar.

In that sense, Iyer-Raniga and Treloar (2000) stress some important issues about sustainable development: a) interdisciplinary approach, needed due to the complex nature of the subject; b) environmental damages can be caused by slow changes, so it is necessary to be aware and attentive to these changes, since its outcome and effects can be drastic and devastating; and c) natural and social environment, in constant change and interrelated. In that way, sustainable development is a constructive process of a given goal, and not a state, that is, it is necessary to follow a long way towards sustainable development (Iyer-Raninga & Treloar, 2000).

Sustainability imply in complex issues, being necessary conjoint actions to better address and solve them (Banerjee, 2001; Iyer-Raniga & Treloar, 2000; Wals & Schwarzin, 2012). Wals and Schwarzin (2012) highlight that a sustainable organization is not the one that only keeps profits, but the one that is able to find equilibrium among people, prosperity and planet through finding out a dynamic balance among these three P's.

To address sustainability challenges, Wals and Schwarzin (2012) recommend dialogic interaction as an efficient mean to promote organizational sustainability. They propose a framework, assuming that the interaction among factors in influenced by the entire environment, current and past relationships, as well as the whole communication process.

Dialogic interaction is defined as a reflexive conversation, and the involvement among heterogeneous groups of people, that explore the diversity in a respectable and collaborative way. It is known as an interaction that includes potentially high levels of community and organizational learning towards sustainability (Wals & Schwarzin, 2012).

The ability of having together in a unique group different people, with different opinion and perspectives, requires ability for managing and taking advantage of these interactions. Some principles must be followed to apply a dialogic dynamic (Wals & Schwarzin, 2012), that is, listening and being able to put some judgements or emotional issues on standby, to better evaluate the situation. Acting calmly is also an important capability, and it means being assertive, but not aggressive, as a good strategy for managing sustainable issues within the company.

Wals and Schwarzin's (2012) framework brings an important element, by stating three axes that connect triangle vertices, representing the interaction among the three spheres of influence. These three spheres refer to: personal sphere (dialogic interaction capacity), interpersonal sphere (group dynamics) and contextual sphere (interaction with the environment). These factors are mutually interdependent and do not operate alone, representing a key characteristic of sustainability.

Thus, in addition to the value that must be given for sustainability by individuals, organizations should develop some skills in sustainable development (Wals & Schwarzin, 2012). With emphasis on learning process, these skills refer to people, organizations and communities' capacities and abilities to deal with sustainability problems. The following question remains: what are the capabilities that people, organizations and communities need to achieve in order to change their behavior and move towards a more pro-environmental attitudes, or at least, less harmful?

Banerjee (2001) identified different levels of strategical focus in companies when investigating entrepreneurs' perception of sustainable actions undertaken in their companies. Some companies seem to integrate environmental issues in higher levels of strategy than others. Top managers recognise the importance on acknowledge their companies' impact on the environment, and the urgent need for mitigating theses effects.

They agree that is necessary to be sensitive to environmental problems and to take into account external stakeholders, undertaking action for the local community and being good corporate citizens. So, although their actions usually aim at economic benefits, they recognise their responsibility. The environmental orientation seems to reflect managers' awareness about environmental issues related to their companies and their responsibility (responsiveness) towards external stakeholders (Banerjee, 2001).

Yet, how to balance the triple bottom line? Maybe here lies the greatest challenge. But at the same time, it is certainly possible, since some developed countries were able to reach good levels of environmental awareness in society, individuals and companies' levels, as Denmark, for example, that has the highest market share of the food and drink market for organic products together with Switzerland and Austria (Cottingham, 2013). No matter how challenging it may seem, the purpose of sustainable development involves the construction of a developmentalist model that includes economic benefits, preservation of environmental resources and social justice, with no supremacy of one domain over the other.

Considering that society, companies and governments' needs are dynamic and the process of change proposed by sustainable development concept is continuous, emerges the need for approaching the innovation concept.

Sustainability requires several changes and innovations, not only within the company, but generally for society. Technological change is linked to structural and cultural changes, requiring some important transformations and transitions (Elzen & Wieczorek, 2005). In order to effectively address and stimulate these transitions, it is necessary to understand its dynamics:

- Characteristic 1: Transitions take place as comprehensive systems in relation to human needs. Each system is characterized by a number of technologies, infrastructure behaviour patterns, cultural values and policies.
- Characteristic 2: Transitions entail changes in processes across multiple dimensions. They are therefore characterized as a mix of technical and social / behavioral changes, also described as coevolution (Elzen & Wieczorek, 2005).

In addition, transitions should present the following elements: i) multi-actors: including companies, consumers, non-governmental organizations (NGOs), producers and governments; ii) multi-factors: transitions are not caused by a single factor, they are usually a conjoint result of several factors that influence each other, these factors can be

technical, regulatory, societal and derived from a change in behaviour; iii) multi-level: transitions imply changes in several levels. At the micro level, with individual actions, at meso, with a paradigm and rules structure, changing systems, and at the macro level, with the understanding of society's cultural characteristics and other aspects, such as individualism and globalization (Elzen & Wieczorek, 2005). In the next section, innovation and innovation types' literature are reviewed in order to introduce eco-innovation literature.

2.2 INNOVATION

Innovation scholars bring this concept as a *sine qua non* condition for economic progress and a critical element for companies and countries to succeed (Dosi, 1988; Freeman & Soete, 2008; Knight, 1967; Rowley, Baregheh, & Sambrook, 2011; Schumpeter, 2008). Innovation is important not only for increasing wealth and prosperity, but also to allow people to do things that had never been previously done (Freeman & Soete, 2008).

In that sense, an economic system tends to equilibrium according to Schumpeterian circular flow, although this equilibrium is not the same over the time (Schumpeter, 2008). Schumpeter (2008) considers development those economic changes that emerge from inside the organization, not those that are imposed from outside. Development is, therefore, a distinct phenomenon from the circular flow and equilibrium trends. Development is a spontaneous and discontinuous change in flow channels, disturbing the equilibrium in a way that will change equilibrium stage previously stablished forever (Schumpeter, 2008).

An emphasis on technological change and innovation on economic change theory is central for Dosi (1988). The following factors, related to the external environment will shape: a) technological progress rates; b) technological trajectories advancing within a limited set of paradigms; c) selection criteria for one of possible paradigms (Dosi, 1988).

Technological progress is irreversible (Dosi, 1988) and innovation models have some common features. First, "normal" patterns of technological change tend to follow paths defined by specific sets of knowledge and *expertise*. Second, discontinuities in pattern changes are associated with changes in technological paradigms. Third, irreversibility in the technological advances also means changes in a group of production possibilities that define changes within any group (Dosi, 1988).

In a given industry, all companies are on the same production's function and their techniques are selected according to relative proportion of price's factor, moving along the function as long as the proportion changes. However, innovation aim is actually to move to other production curve, and not to stuck in the same production's function (Lall, 1992). Therefore, if a company in a given industry or sector, successfully introduces an important innovation, it will be rewarded with high profits. This will eventually serve as a signal to other firms (imitators) that will go into the sector or industry aiming at sharing the benefits (Fagerberg 2005).

To Dosi (1988), innovation appropriabilities tend to be different across different industries and technologies, as well as innovation processes will differ not only according to the economic sector, but also according to the field of knowledge, type of innovation, historical period and country in debate (Pavitt, 2005). The degree of appropriability is related to the prevention of imitation, dissemination and distribution of profits with other firms, users and consumers (Dosi, 1988).

The definition of technology is related to the production or acquisition of food, clothing, housing and other human needs. The expression "Technology" as more systematic and formal body of knowledge started to be used when production techniques have reached a stage of complexity in which traditional methods (learning by doing) were no longer sufficient (Freeman & Soete, 2008). An unsolved problem does not mean that it is insoluble, as well as not all economic changes can be explained by a previous change. At the same time, we cannot always explain current economics stage of a nation based on previous economic conditions, but we should take into account the whole previous situation (Schumpeter, 2008).

Innovation process must consider some issues, according Ettlie (1983), which includes: i) what is the incentive or motivation for innovation?; ii) how to reconcile the apparent contradiction in the literature regarding to the relative importance of market stimulus *versus* technological opportunities? That is, why a company chooses innovation and not another strategy when stimulated to increase performance?; iii) once innovation strategy is chosen, what are the important capabilities for start acting?; iv) how strategic policy goes to an integrated process of innovation? (Ettlie, 1983).

Pavitt (2005) highlights three sub-processes of innovation: i) knowledge production; ii) transformation of this knowledge into devices (products, systems, processes and services); iii) continually must to connected the previous item to demands and needs from the market. Thus, for any level of opportunities, private or economically

motivated, agents will only invest if there is a real market willing to pay for it, and these agents (generally companies) will be able to address the exact market share willing to pay more for it (Dosi, 1988).

Coombs (1988) states that although the emphasis in the 1970 was in studying the influence of demand-pull versus technology push, much more emphasis was given to the demand side than to technology. The author emphasizes the importance given at that time to technological opportunities (Coombs, 1988). Business behaviour and industry's structure can be shaped by the manner in which technology has been developed, at least as much as the nature of innovation depends on company's behaviour and market's structure (Nelson, 1988).

Knight (1967) discusses the factors that influence firm's innovativeness. To analyse innovation process, it is important to consider how to solve problems in the organization and its desire for different types of innovation (Knight, 1967). Drawing on the innovation concept as the adoption of a change that is new to the organization and relevant to the environment, the insertion of the word "adoption" indicates that the company has move from the level of ideas towards practice. It means that: innovation of a new product happen when the product is designed, produced and used. The innovation of a productive process is complete only after the operation. The innovation of the organizational structure occurs when the system has been configured and operationalized (Knight, 1967).

To prosper in innovation it is necessary to succeed in the market. To achieve this, company usually needs to combine different types of knowledge, skills, abilities and resources, so it needs to have the ability of identify opportunities and use them, not necessarily by opening new markets, but also by offering new ways to serve those established and mature ones (Fagerberg, 2005; Knight, 1967; Tidd, Bessant, & Pavitt, 2008; Schumpeter, 2008).

The concept of innovation is related to the search and the discovery, experimentation, development, imitation and adoption of new products, new productive processes and new organizational settings. Almost by definition, what is sought cannot be known before the activity itself of search and experimentation. Likewise, innovation results, technical and commercial, can hardly be known *ex ante* (Dosi, 1988).

Schumpeter (2008) inquires about the origin of resources for acquire means of production, if the individual does not have it. And Schumpeter is categorical, resources

and profits do not emerge from parsimony, but from successful innovation, that is from business profits, and this should feed innovations (Schumpeter, 2008; Teece, 1998).

Uncertainty, a fundamental element of innovation concept, does not mean only lack of information, but also: a) presence of technical-economics problems, in which procedures to solve are unknown; b) when it is not possible to precisely delineate all consequences of given actions (Dosi, 1988).

Another important characteristic of innovation is its systemic nature, since it results from a continuous interaction among different agents and organizations, such as companies (clients, suppliers, and competitors), research organizations (universities, public and private research centres) and public institutions (technology centres, development agencies) (Asheim & Gertler, 2005; Ettlie, 1983; Fagerberg, 2005). Systemic nature goes beyond these interactions and relationships developed from innovation process. Relationships should be characterized by a certain degree of interdependence to be known as systemic, no matter if physically and geographically close or not (Asheim & Gertler, 2005; Fagerberg, 2005).

The approach to study innovation is transdisciplinary, bringing insights from different subjects to compose an understanding of innovation (Fagerberg, 2005). Economists consider resources' allocation, while innovation process is considered a "black box", and, studying of what is behind the black box is left for researchers from other courses (Fagerberg, 2005). In this process, a good part of what happens has to do with learning process, which is studied by cognitive sciences.

Technological knowledge is not shared equally among firms or transferred along them. But such transfer necessarily involves learning (Lall, 1992). The ability to interpret the local codes in a consistent way can be critical to integration of the firm within a local network learning (Asheim and Gertler, 2005).

Innovation requires improvements and changes in technical and organizational systems, which involves trial, error and learning (Tidd, Bessant, & Pavitt, 2008). When a company finds out how to explore latent and potential ideas that emerge and is able to combine factors in an effective way, it can be called an innovative company (Francis & Bessant, 2005).

The development of essential capacities for innovation is the result of a complex interaction of incentive's structures (mediated by government interventions to overcome market failures), human resources, technological effort and institutional factors (each one

also strongly affected by failures market and therefore the need for corrective interventions) (Lall, 1992).

Companies and innovation process are path dependent, what can *a priori* turn companies that were innovative in the past to be considered as potential innovators in the present (Horbach, 2008). What "new" or "newness" is dependent on the context where the company or the market takes place (Carrillo-Hermosilla, Del Río, & Könnölä, 2010). Nevertheless, innovation process can also be refrained by path dependency, what can turn certain aspects of innovation dependent on a given industry, company or technological field (Pavitt, 2005).

For eco-innovation, what is stated above can turn to be a barrier, since the context in which it is developed is usually a conventional scenario, in which the *modus operandi* is normally different from what has been proposed. Anyhow, there are already eco-innovations in the market, and it would be relevant to understand how successful companies could transpose those barriers.

Do eco-innovations go (or potentially go) beyond what is pre-established for the market? Being path dependency a barrier, do companies that overtake this fact and are able to eco-innovate increase their performance? Can companies that invest in eco-innovation go beyond its path dependency and move forward to a better understanding of consumers and companies' needs?

Firms need to innovate, so, in response to demands and consumer's lifestyles changes, and to take advantage of the opportunities offered by technology and markets, structures and dynamics also changes. Maybe this is an important point that eco-innovation concept now encompasses and that makes it a special type of innovation. Not all innovations are eco-innovations, but all eco-innovations are innovations, with some important features that set them apart.

Although consumers may indicate changes, influence demand and market characteristics, producers are responsible for starting economic changes, and consumers can be educated by them. In many industries, technological advancement process has a strong internal logic, which influences what demand may or may not find. If necessary, consumers are taught to desire new things, or things that differ slightly in one aspect or another from those products that they were used to have (Nelson, 1988; Schumpeter, 2008).

However, among changes in society, upsurge a new concept of citizen-consumers, who requires more from companies than simple satisfaction of their demands (Brom,

Visak, & Mejiboom, 2007; Spaargaren & Oosterveer, 2010; Verbeke, Pérez-Cueto, de Barcellos, Krystallis, & Grunert, 2010). It requires an approach that goes beyond the search for the scope of the opportunities of technology, not diminishing the importance of this, but also taking into account other issues that are often neglected.

Although Freeman and Soete (2008) discuss innovation limits and criticize the sentence "we cannot stop technical progress", since it is not acceptable to only "*laissez-innover*" (Freeman & Soete, 2008), innovation literature focus is on technological change and is implemented with market success which is materialized with profits. Eco-innovation is also implemented with market success, but it must go beyond, mitigating environmental impacts, and must be compared with similar alternatives. Next section will bring a literature review on innovation types.

2.2.1 Types of innovation and eco-innovation

To investigate if eco-innovation could be analysed in the light of similar drivers and motivations for adopting innovation, these later already well known and validated, it is necessary to elaborate on this topic, and study what are the main typologies in innovation literature. In this section, an overall of the main types of innovation is presented and summarized in Table 1.

Table 1. Main types of innovation

Author	Types
Schumpeter	1) Introduction of a new good; 2) Introduction of a new production process; 3) Opening a new market; 4) Conquest of a new source of raw materials or semi-manufactured goods' supply; 5) Establishment of a new organisation in any industry.
Coombs (1988)	1960-1970 – emphasis on studying innovation influences - demand-pull versus technology push, more emphasis to demand side than technology.
Zawislak *et al.* (2012)	Development innovation, operational innovation, management innovation, transaction innovation
Francis e Bessant (2005)	P1 innovation to introduce or improve products
	P2 innovation that introduces or improves process
	P3 innovation to define or redefine positioning of the company or its products
	P4 innovation to define or redefine the main paradigm of the company.
Knight (1967)	1. Product and service innovation
	2. Productive process innovation
	3. Organisational structure innovation
	4. Human resources (people) innovation
OECD (1997)	1. Product Innovation 2. Process Innovation 3. Marketing Innovation 4. Organisational Innovation

Schumpeter (2008) describes five innovations: 1) Introduction of a new good – that is, an unacquainted and new good for consumers or a good with a new feature; 2) Introduction of a new production process – that is, a method that has not yet been tested by the specific industry where will be implemented, no need to be a scientifically new discovery, can also be a new way of commercially marketing a specific good; 3) Opening of a new market – that is, a market in which the particular industry has not yet entered, whether this market had existed or not before; 4) Conquest of a new source of raw materials or semi-manufactured goods' supply, again does not matter if this supply had already existed or was created; and 5) Establishment of a new organisation in any industry, e.g. creation of a monopoly or fragmenting a monopolistic position.

Oslo manual classifies innovation into four types (OECD, 1997): product, process, marketing and organisational. Product innovation means not only an introduction of new or improved good, but also significant amendments on technical specifications, components, materials, among other functional characteristics. Process innovation includes technical changes, softwares and equipments. Marketing innovation is related to new product designs, packaging, price or promotion. Finally, organisational innovation is related to company's business practices, both in internal and external relationships.

Zawislak, Bignetti, Alves, Tello-Gamarra, & Barbieux (2012), in order to elaborate on innovation dynamics, relate established innovation types to internal capabilities to achieve it, once innovation can only emerge from companies' specific characteristics. Based on Coase's evolutionary theory, and neo-schumpeterian theory of cost transaction, they identified the following capabilities: development, operational, management and transaction capability. From these capabilities, they classified innovation as following: i) development innovation (company's ability to develop new products and new technologies); ii) operational innovation (ability to develop or improve process); iii) management innovation (ability to develop new business models, new strategies for decision making and routines); iv) transaction innovation (aiming at reducing transaction costs, looking for new ways of purchasing from suppliers and selling for consumers) (Zawislak *et al.*, 2012).

Francis and Bessant (2005) consider four types: first, innovation to introduce or improve products, where companies must find new ways to provide a superior functionality and/or pricing, and signalise this to the market. Any initiative, in which value added exceeds cost, should be held. The second type refers to an innovation that

introduces or improves process. Several small enhancements can build up into large earnings. Important processes can be improved or rebuilt, maybe incorporating new technologies (Francis & Bessant, 2005).

The third type refers to an innovation to define or redefine the positioning of the company or its products, referring more to an alteration in the meaning than to a shift in market segmentation. Some positioning innovations are very radical and could be considered as a change in paradigm, which is actually the fourth type, representing a fully shift in the company's business model (Francis & Bessant, 2005).

Francis and Bressant (2005), regarding the above described innovation types, first address them in a stationary level, in which companies are willing to do what they usually do, but better. However, their emphasis is to stimulate companies to apply strategies that are "outside the box". It means that companies should identify radical options, learn of doing different using those four types of innovation (Francis & Bessant, 2005).

These discontinuities (change in the current paradigm – changing the business model) can arise from technological changes, moving the possibilities border, but discontinuity can also come up from the demand side, with the emergence of a new market and its new rules. Some markets, as the food industry for example, is a potential innovator due to its particular characteristics. Some changes and transformations, even when apparently small and less relevant, turn to be considered as radical due to its extension and the level of changings that the industry and the company need to address to suit in the food sector.

Rowley, Baregheh and Sambrook (2011) in an attempt to integrate what has been studied in relation to innovation typology, bring up new insights on definitions and on the relationships among these distinct types. Although some authors consider radical or incremental innovation as different typologies, others consider it as attributes that can be present in all different types of innovation (Rowley, Baregheh, & Sambrook, 2011; Zawislak *et al.*, 2012). Regarding how radical innovation can be, Knight (1967) defines that this analysis must be done in the light of "the extent to which the new differs from existing alternatives".

In addition to classifying innovation according to its typology, it is important to identify the degree of change that is promoted in the industry. Discontinuous innovation brings a significant level of change, not only for the organisation, but also for the whole industry (Rowley, Baregheh, & Sambrook, 2011). Thus, there are some similarities between discontinuous innovation and paradigm innovation.

Classifying innovation is not that easy since innovation is not a single phenomenon. One type of innovation can be associated to other types and even push towards changes that will influence the development of other types of innovation (Knight, 1967; Rowley, Baregheh, & Sambrook, 2011).

Knight (1967) developed four main types of innovation: 1. Product and service innovation. 2. Productive process innovation – introduction of new elements on organisational tasks, decision making and information systems. 3. Organisational structure innovation. 4. Human resources (people) innovation – that is, through hiring or firing or changing believe, behaviours, training and education.

Although eco-innovation is an innovation, the literature does not include environmental, sustainable, ecological or green innovation as a "type". However, being eco-innovation an innovation, (as it has been classified in eco-innovation literature) it is considered a special type of innovation and can be classified as any of those types listed in Table 1.

To succeed, eco-innovation must build relevant social structures, what innovation should also be able to do in many cases. Nevertheless, when researching innovation literature, only a small part of technological development is performed in a way that creates changes in that sense (Hellström, 2007).

In the next section, eco-innovation concept is approached, as a step forward from innovation and a way to integrate innovation and sustainability.

2.3 ECO-INNOVATION

In this section, literature review about eco-innovation is divided in concepts and definition (section 2.3.1) and eco-innovation and its foundation basis (section 2.3.2).

2.3.1 Eco-innovation concepts and definitions

Boons and Lüdeke-Freund (2013) refer to eco-innovation studies as the search of new technologies and new social practices that make society more sustainable. The authors define eco-innovation as being transdisciplinary, what lead to the use of different terms, sustainable innovation, green innovation, environmental innovation, and eco-innovation, as it is called in this research. De Marchi (2012) and Díaz-García, González-

Moreno and Sáez-Martínez (2015) consider eco-innovation, sustainable, environmental and green innovation as synonyms. Rennings (2000) states that this triple approach (economic, social and environmental) requires an interdisciplinary view, bringing insights from environmental and innovation areas. Being successful in the market is essential for green products help companies and society in the transition for an environmental sustainability (Dangelico, 2015; Pujari, 2006).

Eco-innovations can be defined based on environmental performance resulted from its production and consumption, rather than on the environmental aim, since what really matters is the existence of positive effects related to its use (Kemp & Pearson, 2007; OECD, 2009). There are different types of eco-innovation, and levels of maturity (Del Río, Carrillo-Hermosilla, & Könnölä, 2010). For being an incipient concept, eco-innovation can also be considered as a representative of technological frontier where companies are also still learning and dealing with uncertainties to achieve better performance from the adoption (De Marchi, 2012).

Rennings (2000) explains eco-innovation as a redefinition of innovation and states that innovation categories stated by OECD (process, product, organizational) are useful, but not enough to study sustainable development issues included in innovation. Horbach, Rammer and Rennings (2012, p. 119) define eco-innovation:

> Product, process, marketing, and organizational innovations, leading to a noticeable reduction in environmental burdens. Positive environmental effects can be explicit goals or side-effects of innovations. They can occur within the respective companies or through customer use of products or services.

Horbach, Rammer and Rennings (2012) classify eco-innovation according to the environmental impact and investigate differences among drivers for these different eco-innovations. Environmental regulation, cost savings and clients benefit are the main reason to boost adoption of eco-innovation (Horbach, Rammer, & Rennings, 2012).

In a systematic review with 35 papers that study drivers for adoption of eco-innovation, results point out that most of the papers defined eco-innovation by a similar definition as OECD (Bossle, De Barcellos, Vieira, & Sauvée, 2016). 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 previous intentionality is out of question in this definition (see Table 2).

Some papers also included explicitly 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 (Bossle *et al.*, 2016).

Table 2. 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 & Pearson, 2008).	Antonioli *et al.* (2013); Beise & Rennings (2005); Buttol *et al.* (2012); Cainelli, Mazzanti, & Montresor (2012); De Marchi (2012); Horbach (2008); Horbach, Rammer, & Rennings (2012); Oltra & Jean (2009); Rennings *et al.* (2006); Theyel (2000)
• OECD (used in this paper)	Demirel & Kesidou (2011); Kesidou & 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 & Cohen (2003); Chang (2011); Chen (2008); Chen *et al.* (2012); Chiou *et al.* (2011); Eiadat *et al.* (2008); Gauthier & Wooldridge (2012); Huber (2008); Paraschiv *et al.* (2012); Tseng *et al.* (2013) Weng & Lin (2011)
… a way to improve environmental and/or social performance	Arnold & Hockerts (2011); Carrillo-Hermosilla, Del Río, & Könnölä (2010); Chang & Chen (2013); Huang, Ding, & Kao (2009); Verghese & Lewis (2007)
… a mean to boost product differentiation	Azzone & Noci (1998)
... a way to improve eco-efficiency at the country level, companies are means for implementing tools to improve eco-innovation and eco-efficiency	Beise & Rennings (2005)
… a way to improve holistic green innovation systems or radical innovation	Bergquist & Soderholm (2005); Geffen & Rothenberg (2000)
… specific green technologies	Arnold & Hockerts (2011); Chappin *et al.*, 2009); Qi *et al.* (2010)
… a response to environmental pressure	Green *et al.* (1994)

Source: Bossle *et al.* (2016, p. 866)

Another issue of concern when studying a new subject such as eco-innovation is: How to select companies to include in the research? That is, what are the criteria to define if a company is an eco-innovator? So, in the systematic review, in addition to the analysis of how the concept has been studied in the literature, the criteria to select the object for measuring the influential factors for adoption of eco-innovation was also investigated. In other words, it was analysed how companies' database were selected to participate of the reviewed papers. The main purpose of this analysis is to envision how strict the studies were with the chosen sample in relation to the level of eco-innovation that the companies must have presented to be suitable for participating at the empirical studies (Bossle *et al.*, 2016).

Case studies were performed with companies that are traditionally aware of the importance of integrate environmental strategies into management (Arnold & Hockerts,

2011; Carrillo-Hermosilla, Del Río, & Könnölä, 2010; Geffen & Rothenberg, 2000; Tseng *et al.*, 2013) or in adopting green technologies (Beise & Rennings, 2005; Bergquist & Soderholm, 2005; Chappin *et al.*, 2009; Chen, Chang, & Wu, 2012; Gauthier & Wooldridge, 2012; Green, McMeekin, &Irwin, 1994; Oltra & Jean, 2009; Verghese & Lewis, 2007). Several studies gathered data on national surveys (Antonioli, Mancinelli, & Mazzanti, 2013; Cainelli, Mazzanti, & Montresor, 2012; De Marchi, 2012; Demirel & Kesidou, 2011; Horbach, 2008; Horbach, Rammer, & Rennings, 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, it was also used environmental patents in some cases (Berrone *et al.*, 2013; Brunnermeier & Cohen, 2003; Oltra & Jean, 2009) or the sector (Eiadat *et al.*, 2008; Geffen & Rothenberg, 2000; Chang, 2011, Chang & 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 & Lin, 2011) or based on environmental certifications (Huang, Ding, & Kao, 2009).

As 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 isn't 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 selected 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 (Bossle *et al.*, 2016).

In the next section, eco-innovation is still under study, and its basis and foundations are discussed. Determinants for adoption of eco-innovation are presented, leading to the discussion on the relationship among innovation, sustainable development and eco-innovation. Finally, the theoretical framework is built upon the body of literature found for this thesis.

2.3.2 Eco-innovation and its basis of foundation

Eco-innovation scholars are often brought into the query if those innovations must be studied with a specific approach or not (De Marchi, 2012). This study has been questioned about that as well, and after doing a research on innovation literature, it had been found out that innovation does not bring enough instruments to study eco-innovation. In addition, eco-innovation differentiates in at least two aspects, both in its externalities and regarding the drivers that boost adoption and development of eco-innovation (De Marchi, 2012), as can it be further seen in section 2.5.

In addition, Rennings (2000) emphasizes the need of more intense regulatory push/pull effect on eco-innovations due to the double externality problem. That is, higher costs to act pro-environmentally by implementing an eco-innovation, for example, could refrain companies from adopt it, while a legal requirement and public policies would be an important issue to push companies in this direction (Del Río, 2005).

Eco-innovations hold specific features, such as the importance of creating links and positive trade-offs between the attribute of environmental protection and other critical factors of competitive products and services, such as style, design, price and performance (Carrillo-Hermosilla, Del Río, & Könnölä, 2010). Eco-innovation is the technological and organizational innovation related to the implementation of the sustainable development (Faucheux, Hue, & Nicolaï, 2006; Paraschiv *et al.*, 2012). Therefore, applying and assimilating innovation and sustainability in business management are crucial to achieve sustainability main objectives (social, economic and environmental) (Korhonen, 2001).

Companies face different pressures for not only increasing environmental concern, but also from international competition and other market forces such as industry and economy-wide characteristics (Brunnermeier & Cohen, 2003). A growing number of companies will consider the need and opportunity of integrating anticipatory environmental characteristics into innovation-based strategies, and therefore be tempt to modify their business policies for environmental management (Azzone & Noci, 1998).

From an economic point of view, the decision for adopting an eco-innovation or an environmental strategy must bring superior or equal benefits in relation to the costs. Eiadat *et al.* (2008) consider three types of benefits: anticipating to stringent environmental regulation, a source of competitive advantage (performance), and improving image and acceptability.

Eco-innovations are an important instrument, since they can stimulate an increasing adoption of clean technologies to reduce environmental impacts and alleviate the trade-offs between environmental protection and economic growth, something that still exists for some companies (Demirel & Kesidou, 2011).

Companies need to be approved by the market and therefore are very vulnerable to social influence (Berrone *et al.*, 2013). Environmental pressures could lead eco-innovation to be an important and strategic tool to obtain sustainable development in manufacturing industries (Chang, 2011). One of the attractive main points of eco-innovations for the companies, from an economic point of view, is due to the enhancement of product value and a possible decrease of costs due to higher efficiency (Chang, 2011).

To move towards a more sustainable world, changes in production and consumption patterns must be achieved (Del Río, 2005). Eco-innovations have become, therefore, an important strategic tool to achieve sustainable development (Bossle *et al.*, 2016; Chen, Chang, & Wu, 2012; Chen, Lai, & Wen, 2006; Kesidou & Demirel, 2012). Not only for its potential to reduce environmental impact, but also for improving competitiveness of firms and countries that eco-innovate (Chang 2011; Kesidou & Demirel 2012), by creating new jobs, for example (Paraschiv *et al.*, 2012). Green competitiveness goes beyond consumerism, it is associated with companies' general requirements to build a good image among its stakeholders (Andersen, 2004). Companies are considered as the main source of social and environmental problems in society. Therefore, more restrictive regulatory policies must be developed by governmental and non-governmental organizations to regulate business companies (Azzone & Noci 1998; Schaltegger & Wagner 2011).

Growing importance of environmental dimension leads to a change in companies' value chain cooperation, and requires not only changes in internal management as well as an extra ability to integrate companies' value chain partners (Azzone & Nocci, 1998). Co-operation is even more important for eco-innovation, it is very usual to need changes in raw materials or components, and technological and technical integration with other partners in the chain can be crucial (Buttol *et al.*, 2012; De Marchi, 2012).

Moreover, eco-innovations that succeed are highly dependent on greater participation of stakeholders in their development. Accordingly, they tend to emerge from cooperation between different entities, in addition to the constitution of partnerships

among public sector, academia and private sector (Carrillo-Hermosilla, Del Río, & Könnölä, 2010).

So, innovation and eco-innovation have got some similarities, although some important characteristics differentiate, such as: collaboration and influence from stakeholders (Carrillo-Hermosilla, Del Río, & Könnölä, 2010; Iyer-Raning & Treloar, 2000), mitigation of environmental burdens (OECD, 2009 and others, see Table 2), positive perception of environmental regulation (Halila & Rundquist, 2011) and strong influence from regulatory framework (Boons & Lüdeke-Freund, 2013; Horbach, Rammer, & Rennings, 2012; Kesidou & Demirel, 2012; and others, see Table 4).

Eco-innovation goes beyond ordinary financial goals. 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).

Aiming at understanding how eco-innovation succeed in the market, Halila and Rundquist (2011) compared six eco-innovation cases with six innovation cases to identify success factors that lead to adoption of eco-innovation. Results indicate that successful innovators, both eco or not, have interactions among agents, esteeming cooperative relationships. However, eco-innovators tend to look for support to solve technological problems while other innovators, to raise funding and improving marketing skills. Eco-innovators usually face greater difficulties to attract investment capital (Halila & Rundquist, 2011).

An essential characteristic for innovation, uncertainty (Dosi, 1988) is even greater for eco-innovative products. Success depends on more features, being sometimes more difficulty for eco-innovation, launching successful products and return on investments are not taken for granted (Halila & Rundquist, 2011; Tseng *et al.*, 2013). One big challenge for entrepreneurs and researchers is to seek for creative and efficient ways of incorporating benefits of working in an environmentally friendly atmosphere, combining innovative solutions and bringing up social, economic and environmental paybacks (Porter & Van Der Linde, 1995).

In that sense, including pro-environmental projects into companies' process can trigger innovation that will also reduce costs or increase value of final products or services. These kind of innovation tend to better use inputs, in a more productive way and therefore compensating costs for reducing environmental burdens and consequently

externalities and trade-offs' problems. Being more productive and using resources more rationally will turn the company more competitive (Porter & Van Der Linde, 1995).

Ettlie (1983) framework, presented in Table 3, demonstrates the influence of the context (uncertainty and company's size) on organizational policy (technological, market and performance), that will influence innovation (dependent variable). That is, there is a relationship between strategy and innovation, where uncertainty stimulates and strategical change, leading to innovation (Ettlie, 1983). Market policy refers to the highlighted importance of top management involvement on the innovation process and on commercialization of innovative products. Top management concern can reduce risks and barriers to adoption, help to better integrate technical and market efforts and increasing the likelihood of success by including more competent human resources on innovation process. For both innovation and eco-innovation, strategical and organizational initiatives trigger innovation, although for eco-innovation it has been quantitatively more relevant (Horbach, 2008).

Table 3. Innovation Framework

Context ⟶	**Organizational Policy**	⟶ **Innovation**
1. Environmental uncertainty	1. Technological Policy	1. Product innovation degree
2. Company's size	2. Market Policy	2. Process innovation degree
	3. Performance	

Source: Ettlie (1983)

Beyond the importance of including environmental concepts in corporate strategy, environmental awareness of consumers is also a relevant variable for production and consumption of environmental friendly products (Horbach 2008). Although eco-innovations can be of lower acceptance (Halila & Rundquist 2011), the start for developing, producing and marketing a new green product is also related to its potential to succeed in the market (Dangelico & Pujari 2010). The perception of value of consumers about the insertion of environmental issues in the development of products is a critical issue. Adoption and diffusion of environmental innovative products depends on consumer's evaluation (Huber, 2008; Oltra & Jean, 2009).

Companies must act in a pro-environmental way also because of actions that can pressure both in a regulatory scope and socially, since consumers and other key stakeholders can organize boycott towards irresponsible activities in the environmental field (Chang & Chen, 2013). Successful companies highly value environmental

management, as a core part of their strategic plan is to integrate environmental issues into innovation practices (Chang & Chen, 2013).

Eco-innovation can be boosted both by consumers-side and by companies-side. Increasing consumer awareness and their willingness to behave more pro-environment can lead them to buy eco-innovative products, creating new market opportunities for companies (De Marchi, 2012). Despite the fact consumers play a key role in influencing companies to adopt eco-innovations (Horbach, 2008; Kesidou & Demirel, 2012), the level of investments will almost exclusively depend on other factors, such as reducing resources, companies' organizational capabilities or more stringent regulations (Kesidou and Demirel, 2012). Although the significance of sustainable and innovation issues is highly recognizes, why some companies engage more than others and under what conditions companies decide for the adoption of this kind of innovation is still to be unveiled (Berrone *et al.*, 2013).

So, innovation literature highlights important elements for eco-innovations, from the supply side (technology push) and from the demand side (demand pull), in addition to environmental norms and regulations that play an important role for stimulating eco-innovation (Berrone *et al.*, 2013; Chang & Chen, 2013; Kesidou & Demirel, 2012; Rennings, 2000).

Interventions can be both important for industrial success (Lall, 1992) and to boost eco-innovations (Ettlie, 1983, Horbach, 2008; Kesidou & Demirel, 2012). The need for regulations to protect the environment is widespread but reluctant accepted. Widespread because everyone wants good planet to live, but reluctant since environmental norms are still seen as something that corrode competitiveness (Porter & Van Der Linde, 1995).

Complying with current legislation is also important to reduce costs due to noncompliance, as well as image risks. Regulations can also be seen as an opportunity to create new business models within the company. Environmental sustainability's investments are connected to win-win solution, when companies achieve both improvement in their image and increase competiveness (Dangelico & Pujari, 2010).

As well as innovations, eco-innovations can be radical or incremental. Radical innovations are important for being responsible for a great cost reduction in key economic inputs, and therefore, largely adopted acting as catalyst for structural change (Pavitt, 2005). Eco-innovations are considered radical when it is new in the market or laid on radical new technologies, or that had been patented by the company (Dangelico & Pujari, 2010). Nevertheless, usually the approach is incremental, both when defining the term

(Halila & Rundquist, 2011) and in relation to eco-innovative products, usually remanufactured with recycled or organic materials (Hellström, 2007; Pujari, 2006).

In this regard, even though an eco-innovation is not radical, it can be signed as a starting point and a stimulus for introduction and adoption of an eco-innovation. The hybrid system from Toyota, implemented in the Prius case used electric and petroleum as fuel, not the best solution for the environment, but a good introduction for electric cars (Carrillo-Hermosilla, Del Río, & Könnölä, 2010). Elsewhere, the adoption of ecological products can be considered successful when it enables the full substitution of a similar product that damages the environment, not only when it is one more way for consuming (Pujari, 2006).

Eco-innovations play an important role for economic development, being considered important for companies' competitiveness and for environment preservation. In that sense, eco-industry can even be the main responsible for recovering the world from economic crisis. Costs for reducing CO_2 emissions and for healing from damages caused by climate changes are extremely high, and eco-innovations act for reducing these expenses, since there a reduced amount of emissions generated (Halila & Rundquist, 2011). In addition, the green economy has presented positive rates of growths even when others are decreasing, turning eco-innovation as a main exit strategy from crisis (Buttol *et al.*, 2012).

The next section further explore the relationship among sustainable development, innovation and eco-innovation.

2.4 THE ROLE OF ECO-INNOVATION AS A TOOL FOR SUSTAINABLE DEVELOPMENT

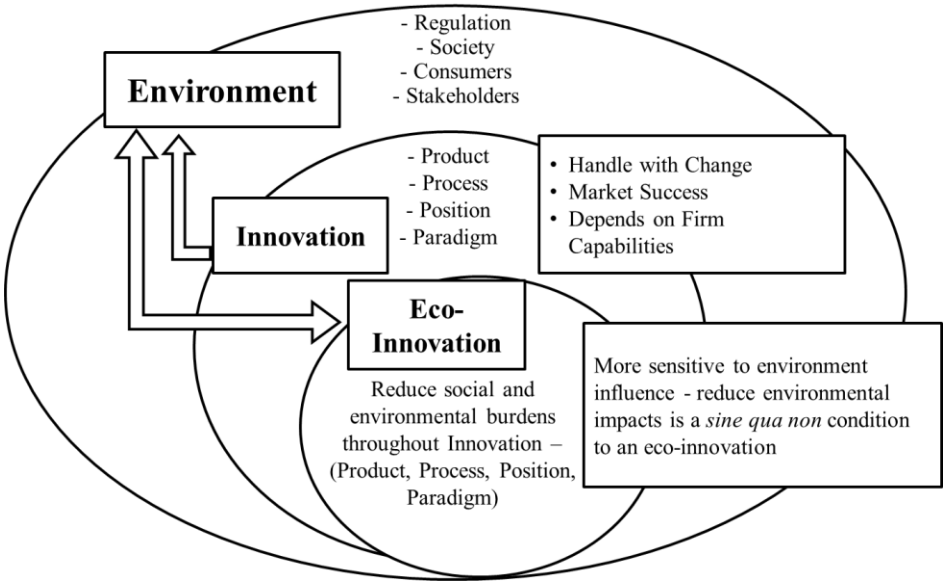
The relationship among sustainable development, innovation and eco-innovation must be further explored, both theoretically and empirically. Sustainable development has its focus in meeting the need of the present, without compromising supply for future generations' needs (World Commission on Environment 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).

The starting point for this study 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, Mancinelli, & Mazzanti, 2013). This thesis focuses on companies that are adopting eco-innovations based on these broader premises: new products, processes or business models that will ultimately reduce an environmental impact. 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).

Therefore, companies must innovate for taking advantage of technological opportunities and changes in markets and dynamics, but also to respond to changes in consumers' demand and lifestyles.

The importance of including stakeholders, people, organizations, industries and communities in the transition to an economy that integrates ecological concepts in innovation strategies and competitiveness is highlighted in the adoption of an eco-innovation strategy. Eco-innovation seems to be more linked to a paradigm shift, a change in philosophy. Figure 1 shows this relationship, where the environment includes stakeholders and society in general, but showing that innovation tends to influence more the environment, while the eco-innovation suffers a significant influence of society, the regulatory framework, and necessarily influences the environment, decreasing environmental burdens. Both innovation and eco-innovation must deal with change, succeed in the markets and, therefore, depends on the internal capabilities of firms.

Figure 1. Central role of eco-innovation for sustainable development and it influence on the environment



Source: De Barcellos *et al.* (2015)

For companies performing in a sustainable way, they must integrate sustainability concerns into their business routines and their strategies, what can bring positive effects on society in the long term (Baumgartner & 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, it will probably not be influencing the same variables with the same strength.

2.5 DRIVERS FOR ADOPTION OF ECO-INNOVATION AND ENHANCEMENT OF ENVIRONMENTAL PERFORMANCE

"The only hope for sustainability is to change forms of consumption. To do so, we must innovate."

World Business Council for Sustainable Development (WBCSD, 2002).

Environmental responsibility for new product development is usually originated from an internal motivation from the company, combined with a potential to succeed in the market and other external forces (Dangelico & Pujari, 2010). So, identifying actual

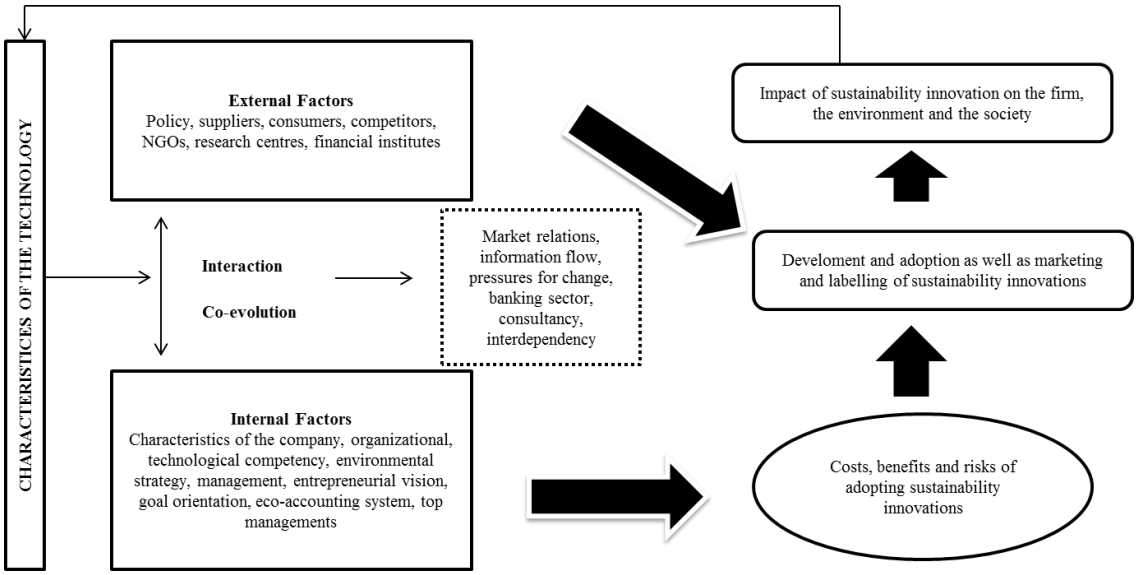
determinant factors for adoption of eco-innovation, that is, what are the drivers that increase adoption of eco-innovation, and consequent performance, is crucial.

By analysing the literature over time, it is possible to identify 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". As can be seen in this section, since the beginning, up to more recent published papers, regulation is moreover a very relevant driver for the adoption of eco-innovation.

Green, McMeekin and Irwin (1994), one of the first papers found in a systematic review to identify drivers for adoption of environmental innovation (Bossle *et al*., 2016), highlight the important role played by regulation. Azzone and Noci (1998) identified three key determinants for a significant change in strategy towards the adoption of eco-innovation: 1) The role of governments (to develop commercial and educative campaigns); 2) Regulations; 3) The adoption of environmental certification practices, e.g. ISO14001. In this case, managerial concerns start to be mentioned as a key determinant for eco-innovations, achieving more relevance over the years.

Arnold and Hockerts (2011) presented the following factors in their final framework: a) external factors: policy, suppliers, consumers, competitors, NGOs, research centres, financing institutes; b) internal factors: characteristics of the firm, organization/technological, competency/environmental strategy, management/financing, entrepreneurial vision, goal-orientation, segmentation e eco-accounting system, change agents and top management; and finally c) technology characteristics: market relationship, information flow, pressures for changing, bank sector, cooperation, collaboration, networks, consultancy, independency. Figure 2 presents the influential factors for the development and adoption of eco-innovations.

Figure 2. Influential factors of adoption of sustainable innovations

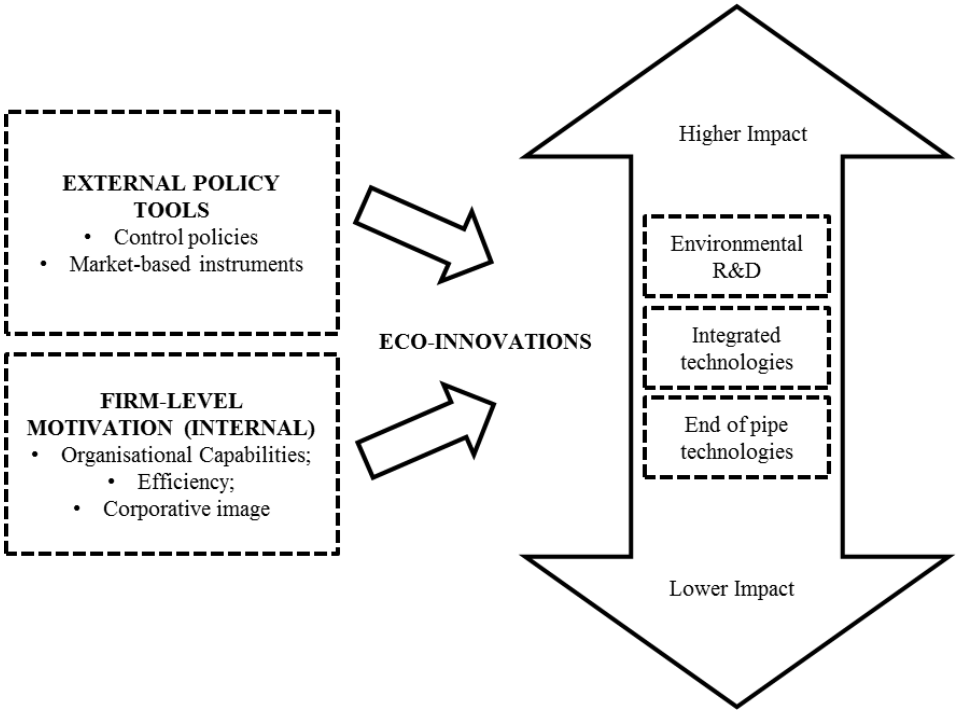


Source: Arnold and Hockerts (2011, p. 404)

A company, to be considered sustainable, must integrate sustainability in its main abilities, skills and capabilities in most areas, such as corporate strategy, governance and stakeholders, clients and products, human resources and financial results (Paraschiv *et al.*, 2012). Demirel and Kesidou (2011) analysed determinants for different eco-innovations, from incremental innovation, with less impact to higher impact eco-innovations, as integrated technologies, cleaner production, environmental resources and development (R&D).

According to Figure 3, external tools for environmental policy are: 1) Control policies (Regulatory Push); 2) Market-based instruments (environmental taxes). Internal motivations at a firm level are: 3) Organisational Capabilities, that is adoption of an Environmental Management System (EMS); 4) Efficiency – that can be: i) saving costs due to an environmental improvement; ii) equipment upgrades to protect the environment; 5) Corporate image, by implementing Corporate Social Responsibility (CSR) (Demirel & Kesidou, 2011). As control variables, the authors have used: size, productivity and the sector's impact.

Figure 3. Influence from internal and external tools for different eco-innovations



Source: Demirel and Kesidou (2011)

Influence from regulation was only significant for incremental innovations (with lower impact), while Research and Development (R&D), higher impact eco-innovations, was mainly influenced by market factors, mainly those related to cost savings. Environmental taxes and the influence of corporate image through corporate social responsibility (CSR) were not influential factors for adoption of eco-innovations. Efficiency (cost savings and equipment's upgrades) was significantly influent, indicating that companies consider more efficient and environmental friendly technologies when renovating their facilities. The size of a company is only relevant for end-of-pipe technologies (Demirel & Kesidou, 2011).

Having an environmental management system (EMS) can positively influence the adoption of eco-innovation, depending on the maturity level of this system. Another important determinant for eco-innovation is the participation of other areas within the company, with strong emphasis on the R&D area. The learning process can be important for product innovation and implementation of an EMS (Rennings *et al.*, 2006).

Green, Mcmeekin and Irwin (1994) state that regulation is one of the most important factors for the adoption of eco-innovation. There are three main factors for boosting eco-innovation in products: i) environmental regulations that exist; ii) anticipating to environmental regulations that may be created; iii) perspective of a growing market for green products. For innovation in process, in addition to the two first

product factors, there is one more; iv) cost savings through better use of materials. Although pressures from environmentalist groups can affect companies' willingness to improve their image, this factor has not been found significant yet. Interestingly, internal pressure and collaboration can be relevant (Green, Mcmeekin, & Irwin, 1994).

Eco-innovation can also be studied in terms of its origins, as in Chen, Chang and Wu (2012), classifying eco-innovation as proactive and reactive, and its origins as internal or external:

a) Internal origins:

(1) Environmental Leadership – a dynamic process where an individual encourage others to contribute for carrying out environmental management and innovation;

(2) Environmental Culture –symbolic context of environmental management and innovation in which the interpretations guide behaviors and members' sensemaking processes;

(3) Environmental capability – abilities from the company to integrate, coordinate, construct and reconfigure competences and resources to comply with environmental management and eco-innovation.

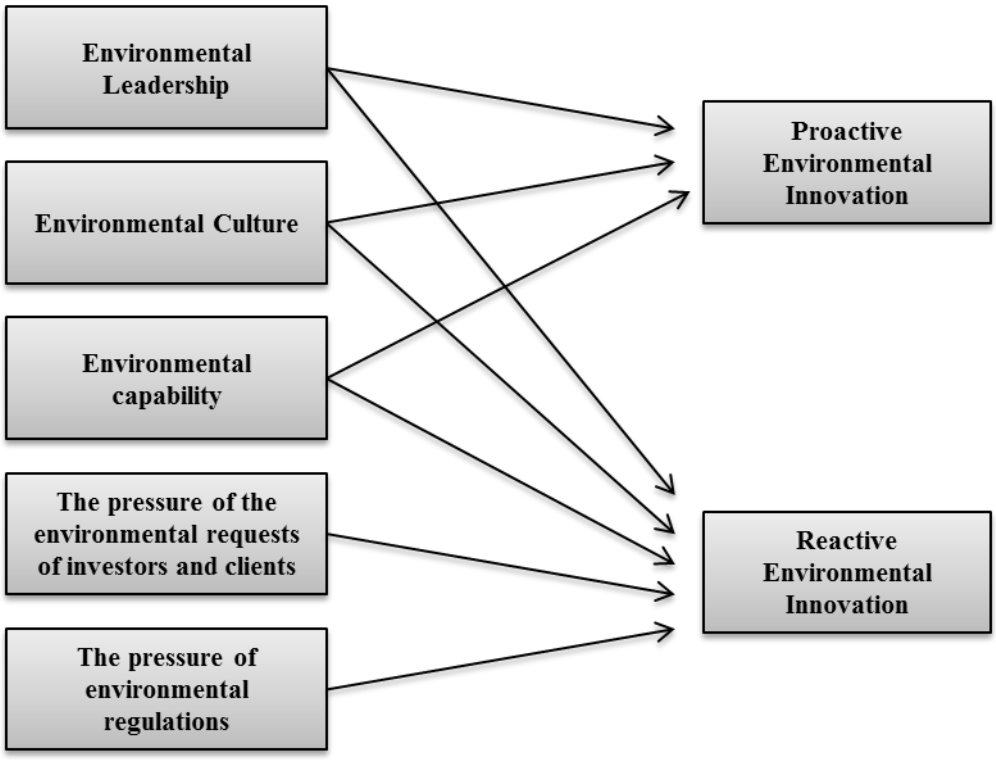
b) External origins:

(4) The pressure of the environmental requests of investors and clients – environmental demands from investors and clients to comply with the requirements of restrictions on hazardous substances, etc., and,

(5) The pressure of environmental regulations – Requirements from local, regional and international environmental regulations.

Chen, Chang and Wu (2012) verified that all origin variables influence reactive eco-innovation, but for the proactive eco-innovations, only some factors are significantly important, as can be seen in Figure 4:

Figure 4. Origins and types of eco-innovation



Source: Chen, Chang and Wu (2012)

One driver that has been stood out is the essential role played by top managers as key player for adoption of eco-innovation, acting as a trigger for the introduction of relevant environmental management practices (Azzone & Noci, 1998). Horbach (2008) also highlights its importance, and Weng and Lin (2011), in the same way, emphasize the influence from quality of human resources, organizational and government support and demand and regulatory pressures.

In the following sections, relevant drivers are described and discussed. This selection includes all relevant drivers for adoption of eco-innovation, drawn to introduce the theoretical framework. The search was focused in finding relevant drivers for adoption of eco-innovation, it was based on a systematic review and resulting framework, that inspired the final conceptual model for this empirical research. Considering that eco-innovation's main focus is to reduce environmental impacts, and therefore increase environmental performance, these drivers also have influence on the perception of a better performance for the company.

2.5.1 Regulatory Pressures

Environmental regulation is the most predominant and relevant driver for adoption of eco-innovation in the literature. The reasons for that are mainly based in two premises. First is the idea that companies do not want to bear with all environmental costs for themselves, while benefits are distributed among everyone, society and government that will be able to enjoy of a cleaner and more sustainable environment. The second reason for this relevance of regulatory pressure is due to the fact that usually papers in this subject empirically study European or North America realities, with strong regulations in that sense. In addition, authors bring several important definitions as explanations, as follows.

Environmental regulation is recognized as the most important driver for many authors (Horbach, 2008; Horbach, Rammer, & Rennings, 2012; Qi *et al.*, 2009, and many others, see Table 4). As stated above, companies consider that benefits from adoption of an eco-innovation are not fully returning, since others are also benefited by their action, and most important by their investments (Del Río, 2005). Therefore, even if by forcing companies, environmental regulations stimulate new environmental solutions that will also benefit companies both economically and managerially (Horbach, 2008). Moreover, will standardize minimum requirements that must be taken by all companies, minimizing production cost differences that usually increase costs for environmental products (Azzone & Noci, 1998).

Companies face these kind of pressure since 1970s (Eiadat *et al.*, 2008), typically from governments, and having high costs for noncompliance (Berrone *et al.*, 2013). Some authors argue that environmental regulations must be very stringent to induce better results for the environment and breakthrough innovations, requiring high standards within the company, qualified personnel, top managers and strategy (Paraschiv *et al.*, 2012).

Governmental environmental policies are relevant (Chappin *et al.*, 2009), and must be not only a regulator, but also a supporter for companies that eco-innovate (Bergquist & Söderholm, 2011). Both by providing and generating knowledge and by spreading environmental awareness for companies and society, while boosting consumers' supporting actions towards these initiatives (Bergquist & Söderholm, 2011). Azzone and Noci (1998) highlight the importance of the role of governments to develop new campaigns aimed at increasing the level of the market environmental awareness.

Interesting this cycle, where the government can put pressure on firms through regulations, what in the first time can result in raising costs but later in more innovation

and investments in R&D (Bergquist & Söderholm, 2011) and better results for the company (Cainelli, Mazzanti, & Montresor, 2012).

In that sense, regulations can use market incentives to draw attention towards management inefficiencies and minimising uncertainties related to time and cost for the introduction of new patterns (Azzone & Noci, 1998). Therefore, regulations can also help to create leading markets in eco-innovation (Beise & Rennings, 2005) and intensifying its use (Demirel & Kesidou, 2011).

Environmental innovation is more likely to occur in industries that have higher levels of foreign competition or that act in the international market (Brunnermeier & Cohen, 2003). Some eco-innovations, such as fuel cells or organic food, for example, must comply with international regulations, that are sometimes stronger that in its home country (Beise & Reinnings, 2005). Occasionally, in developing countries, government intervention and regulations are weak, therefore, impact from environmental regulations can have small or no effect on the adoption of eco-innovation, comparing to other drivers (Ashford, 2002).

Finally, although the highlighted relevance of environmental regulations, the actual effect on the adoption of truly environmental innovation strategy is still in check (Eiadat *et al.*, 2008), mainly regarding other backgrounds, i.e. developing countries.

2.5.2 Normative Pressures

Normative pressure and market demand are also important factors. Companies can face demands from suppliers, consumers, competitors, non-governmental organizations (NGOs), research centres, financing institutes on the adoption of eco-innovation (Arnold & Hockerts, 2011; Beise & Rennings, 2005; Gauthier & Wooldridge, 2012; Huang *et al.*, 2009). 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).

These pressures are usually implicit and threaten companies' legitimacy, leading to a behaviour that meet prevalent norms for their area or sector (Berrone *et al.*, 2013). Normative pressures, from NGOs can also push companies to reduce environmental risks and avoid damages in their images and budget due to externalities' cost (De Marchi, 2012). The physical proximity of groups, such as NGOs can increase the likelihood to increase pressure on the company (Berrone *et al.*, 2013).

2.5.3 Cooperation

Given the systemic and complex characteristic of eco-innovation, the relevance of cooperation is also stressed (Carrillo-Hermosilla *et al.*, 2010; Geffen & Rothenberg, 2000; Verghese & 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.

Therefore, cooperating with local actors, for training, information and knowledge sharing and communication is crucial (Cainelli, Mazzanti, & Montresor, 2012). Integrating a platform for communication can be necessary to analyse the entire life cycle of a given product or process and to stimulate the participation of all stakeholders (Buttol *et al.*, 2012).

Eco-innovations that succeed tend to be a result of intense participation of different stakeholders in different phases of this new product development, as an effect from a cooperation among different partnerships, e.g. public, academic or business sector (Carrillo-Hermosilla, Del Río, & Könnölä, 2010). Cooperation can also be stimulate by the government (Bergquist & Söderholm, 2011).

2.5.4 Technology

To respond to a constantly change in technology and to a shorter product's life cycle, companies must increase their investments in environmental innovations to enhance competitive. Eco-innovation is embedded of a high level of uncertainty, and several resources are consumed throughout the process (Oltra & Jean, 2009; Geffen & Rothenberg, 2000).

Technology might also influence, mainly during the new product development phase, when technological capabilities of the company are strongly needed. Knowledge and physical resources for new product and process development must be funded through investments in R&D and training for employees (Horbach, 2008).

Technology turbulence can be generated by fluctuation in industries' technology standards, and generate uncertainties due to the speed of change and by companies being threatening by not being able to follow (Han, Kim, & Srivastava, 1998).

2.5.5 Efficiency

It seems evident that companies will adopt a new technology to improve internal efficiency (Tseng *et al.*, 2013). Efficiency can be achieved both by cost savings and by equipment's upgrades (Demirel & Kesidou, 2011). Cost savings is an important stimulus for reducing resources' use (such as energy and inputs) (Chappin *et al.*, 2009; Horbach, Rammer, & Rennings, 2012).

2.5.6 Environmental Capability

Considering that some authors consider that innovation can only emerge from companies' internal characteristics (Schumpeter, 2008; Zawislak *et al.*, 2012), environmental capabilities become an important concept for understanding the adoption of eco-innovation.

Environmental capability is firm's abilities to integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations (Chen, Chang, & Wu, 2012). Chen (2008) refers to the importance of core competencies for increasing eco-innovation adoption and companies' image, that is, the capacity to learning and to coordinating different skills and abilities within the company.

2.5.7 Environmental Managerial Concern

The importance of internal elements for better developing environmental issues inside the company must be highlighted. Some authors even say that eco-innovation programmes depend on management abilities and capabilities (Azzone & Nocci, 1998) to succeed. Azzone and Noci (1998) elaborate on the importance of the executives to eco-innovation to: i) management eco-innovation together with all issues related to the success of the company, such as time, quality, etc, environmental issues are one of the challenges for the company, but note the only one; ii) integrating different departments and their actions, since sustainability must permeate the whole company and requires involvement of different departments; iii) develop cooperation with other companies, to

solve common problems or to gather strength to deal with any other question that cannot be manage by a single company, because of its lack in competencies or any other reason; iv) co-operate with public institutions, and getting back support to deal and develop innovative environmental policies.

Eco-innovations must succeed in the market, and since it is a tool for sustainable development, it must achieve its environmental and social goals with superior products and processes with a recognised value for consumers. These value does not occur by chance, but are rather created by leaders that included sustainable values into business, generating products, services, organizational methods, increasing quality and reducing the use of resources (Schaltegger & Wagner, 2011).

Top managers must be recognised by other employees within the company as leaders to envision a systemic and sustainable impact of environmental actions (Azzone & Noci, 1998). These leaders must be able to identify benefits and disadvantages of adoption, and deal with companies' environmental culture (Azzone & Noci, 1998). Managers play a key role in developing companies' strategy, being persuasive for convincing everyone on adopting an environmental strategy if they are personally aware of its importance (Eiadat *et al.*, 2008). Environmental managerial concern was found as the strongest determinant of environmental innovation strategy (Eiadat *et al.*, 2008), and as an important element to creating a good image and reputation.

Finally, companies that are willing to improve their environmental performance need to have managers with a strong environmental awareness, and able to integrate all external and internal pressures to bring it up as better environmental performance. Either by hiring a manager with a historic personal motivation or by training managers for this job are possible ways for integrating this essential piece for adoption of eco-innovation (Qi *et al.*, 2010).

2.5.8 Human Resources

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 & 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 & Lin, 2011).

Although the importance of human resources is evident, training (alone) is not sufficient to increase adoption of eco-innovation (as actually none of the factors alone can be) (Antonioli, Mancinelli, & Mazzanti, 2013).

2.5.9 Environmental Strategy

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 & 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).

Environmental innovation strategy can also be classified as practices to mitigate companies' environmental impact, such as reduction, pollution prevention and adoption of environmental managerial systems (Eiadat *et al.*, 2008). And why companies would integrate sustainability into its strategy? Main reasons for that include a moral duty and responsibility for a clean environment, economic and financial advantages and sustainability as a key element of an organizational culture (Paraschiv *et al.*, 2012).

2.5.10 Size

Some authors state that size affects the adoption of eco-innovation (Antonioli, Mancinelli, & Mazzanti, 2013; Chen, 2008; Demirel & Kesidou, 2011). De Marchi (2012) states that eco-innovative companies are bigger and suggests that size positively affects the propensity to eco-innovate. Small companies are believed to lack of human, technical and financial resources and this would be determinant to decrease adoption of eco-innovations (Del Río, 2009).

Azzone and Noci (1998) believe that the multinational nature of the company can already represents an important driver for the introduction of environmental behaviour. Although De Marchi (2012) highlights difficulties faced by small and medium enterprises

for adoption of cleaner technologies, for Horbach (2008) and Huang *et al.* (2009), size was not a significant influent.

2.5.11 Sector

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. Antonioli, Mancinelli and Mazzanti (2013) also found out more environmental innovations when only polluting sectors are considered.

2.5.12 Age

Although company age has not been significant in Horbach (2008) and Huang *et al.* (2009), it was tested as a control variable. Age should be tested as a potential influent factor of eco-innovation, that is, testing if any of the drivers have a distinct influence on the dependent variable according to companies' age. More experienced companies can present more positive and strength drivers for adoption of eco-innovation (Amores-Salvadó, Martin-de Castro, & Navas-López, 2015).

2.5.13 Performance

"An investment isn't an investment if it destroys our planet."

Greenpeace commenting on plans to drill for oil in the Arctic (July 2015)

Once more, considering the importance to succeed in the market, Horbach, Rammer and Rennings (2012) put emphasis on the significant importance of customer benefits. Consumers will be responsible to improve environmental performance and process innovations by investing in those companies that increase material efficiency, and reduce energy consumption, waste and the use of dangerous substances (Horbach, Rammer, & Rennings, 2012).

Performance is measured by the perception of sales growth, market share and return on investments due to adoption of an eco-innovation (Eiadat *et al.*, 2008). The adoption or development of technologies and practices that mitigate companies' impact in the environment and that significantly improve their environmental performance is

essential (Ashford, 2002). Beise and Rennings (2005) consider market forces stronger than environmental regulations, and emphasise the importance of consumers and that eco-innovations meet performance and ecological criteria.

Table 4 presents a synthesis of the main relevant drivers for adoption of eco-innovation found in the systematic review performed in Bossle *et al.* (2016).

Table 4. Drivers and motivations for the adoption of eco-innovation, their definitions and sources

Variable and Definition	Source
External Factors	Arnold & Hockerts (2011); Azzone & 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)
Regulatory pressures - Determined by governments, noncompliance with regulations can be very costly to the firm (Requests from local, regional and international environmental regulations)	
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); Huang*et 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 - e.g., ISO 14001, that induce the adoption of an Environmental Management System (EMS), TQM	Arnold and Hockerts (2011); Azzone & 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. Managers are more likely to adopt if there is a personal motivation, high value concern related to the environment.	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 - Effects that environmental practices had in the performance: 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 - 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)
Age - Year of stablishment	Horbach (2008) and Huang *et al.* (2009),

Source: Bossle *et al.* (2016, p. 868)

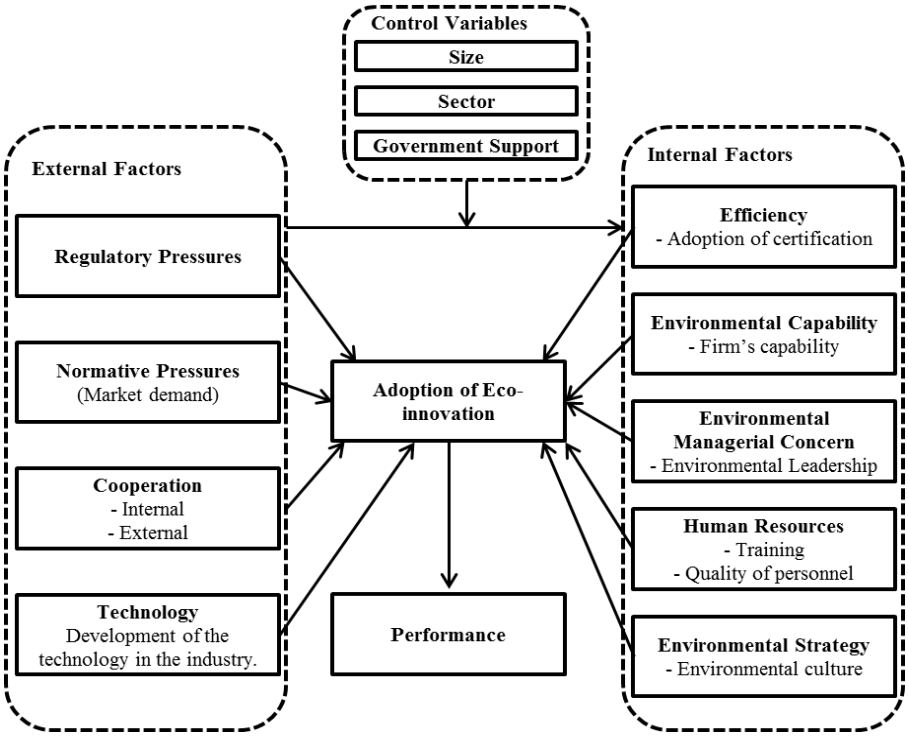
Having that in mind, Bossle *et al.* (2016) proposed to empirically investigate the influence of those drivers on adoption of eco-innovation and split determinants between external and internal factors. According to the framework, external factors, as regulatory pressures, that encompasses international, 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 & Kemp, 2009; 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 can boost adoption of eco-innovation.

Internal factor are related to efficiency, by cost reduction, equipments' updates, investment in R&D or certifications (Green *et al.*, 1994 and others, see Table 4); 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 & Lin, 2011); and environmental strategy, including the culture of the firm, and can also boost adoption of eco-innovation.

All those factors can influence the adoption of eco-innovation by the companies, and (positively) affect the performance, both in economic and environmental terms, as it can be seen in Figure 5. 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. Factors such as firm's size, public financing (government support) and sectorial characteristics can also be determinant for the adoption of eco-innovation.

Figure 5. Drivers for adoption of eco-innovation from systematic review



Source: Bossle *et al. (2016, p. 870)*

In the next chapter, the theoretical model and hypothesis that will be tested in this research are described.

3. CONCEPTUAL MODEL AND HYPOTHESES

"Sensitivity to the competing virtues of parsimony and comprehensiveness is the hallmark of a good theorist"

David A. Whetten (1989)

In order to refine the conceptual model and hypotheses, an exploratory phase was conducted with companies (published in Bossle *et al.*, 2015a), aiming to investigate the conditions that boost adoption of eco-innovation in the food sector in Brazil.

A peculiar result found was that representatives from food companies were moved by their own mission and philosophy for working with a product that provides health and welfare for consumers. Establishing mature eco-innovative food chains, promoting health and protecting the environment, developing suppliers and the food industry in general is definitely a goal for these entrepreneurs. Technology is an essential input to increase the supply of sustainable food, to reduce losses, and, to improve environmental sustainability. Regulations are still seen as incomplete and ineffective, focusing mainly in fruits and vegetables, wherein other products remain uncovered by an organic or other type of eco-innovative background. This complaint about regulations is also related to difficulties reported to communicate to the market about other health and eco-innovative products. Finally, a great potential for this market become bigger was a consensus (see more in Bossle *et al.*, 2015a).

Considering this potential market for eco-innovation products, as well as the possibilities for companies to increase their efficiency through the adoption of environmental process or new organisational methods, it became critical to understand how eco-innovation has been studied in the business literature. After a deep analysis of data collected in the systematic review the conceptual model was drawn, using the knowledge base about drivers and motivations for adoption of eco-innovation.

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,

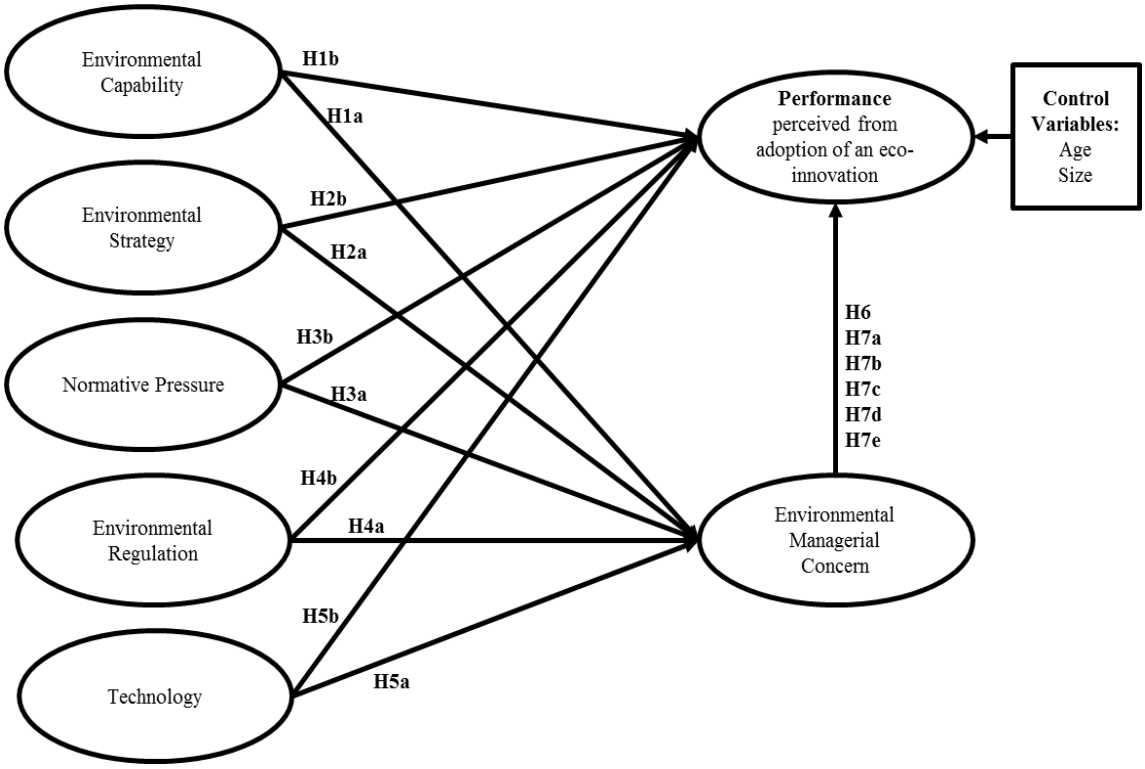
and also to practitioners, that are being constantly pressured to adopt eco-innovative practices (Bossle *et al.*, 2016).

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 & Rennings, 2005; Bergquist & Soderholm, 2005; Geffen & Rothenberg, 2000; Kesidou & Demirel, 2012).

Producing and adopting eco-innovation (product, process, organizational) and companies' environmental performance improvement are complementary and even redundant, considering eco-innovation concept (Eiadat *et al.*, 2008; OECD, 2009). Companies' ability to coordinate resources towards a more environmental management, and to differentiate from competitors, that is, its environmental capability, positively affects performance (Chang & Chen, 2013). Similarly, including environmental awareness into the strategy is a recognised approach to improve performance and increase efficiency (Eiadat *et al.*, 2008 and others, see Table 4). Eco-innovation can be also stimulated by regulations (Eiadat *et al.*, 2008 and others, see Table 4), to make the company more valued, and supplier and other normative pressures, exerted from market forces can also contribute to increase environmental performance, through adoption of environmental innovative materials and processes (Geffen & Rothenberg, 2000 and others, see Table 4). Environmental performance can still be positively influenced by increased levels of environmental innovative technology within the sector, that pushes individual companies to eco-innovate (Geffen & Rothenberg, 2000).

Based on these evidences, the following model was drawn (Figure 6), in which the construct environmental managerial concern is central and fully or partially mediates the influence from environmental capability, strategy, normative and regulatory pressures and technology over the perception of increased performance due to adoption of eco-innovation.

Figure 6. Proposed model



The model can contribute to better understand the dynamic of adoption of eco-innovation and serves 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.

According to the main findings in Bossle *et al.*, 2015a, to raise sustainability and applying 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 & Ebner, 2010). Drivers for the adoption of eco-innovation relates to factors that affects directly or indirectly the companies. Surprisingly these results can bring a contradictory feature to the concept.

3.1 HYPOTHESES

Hypotheses' development is presented as follows.

H1: Environmental capability has a positive effect on (a) environmental managerial concern and on (b) environmental performance

Chen, Chang and Wu (2012) identified environmental capability as firm's abilities to integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations as an internal origin of environmental innovations. That means that as much as a company can differentiate from competitors, that is, reinforcing its green capabilities (Dangelico, 2015), stronger the influence on environmental managerial concern and performance.

The influence of environmental capability for boosting eco-innovation is consistent with Schumpeterian innovation literature and its beliefs that innovation is originated inside the company. Companies will react differently when facing same problems, opportunities or challenges according to their own characteristics, that is, companies will behave according to its environmental capability (Azzone & Noci, 1998). Differences can be due to training or communications' strategies (Cainelli, Mazzanti, & Montresor, 2012) or depending on the available resources (Azzone & Noci, 1998).

H2: Environmental innovation strategy has a positive effect on (a) environmental managerial concern and on (b) environmental performance

To evaluate if environmental innovation is included in the companies' strategy, a four-item instrument on environmental strategy used by Chen *et al.* (2014), adapted from Banerjee, Iyer and Kashyap (2003) was used. This construct can be used to assess if companies that integrate environmental sustainability in the strategy are more willing to improve environmental performance and environmental managerial concern.

For developing an environmental strategy, it is likely to including corporate environmental ethics, put environmental values into companies' strategy, with clear environmental policies, including environmental investments in the budget, and integrating mission and vision (Chang, 2011). The adoption of eco-innovation can be facilitated when the scenario is a company that already behave with sustainable orientation, and strategically positioned as environmental leaders (Gauthier & Wooldridge, 2012).

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 & Hockerts, 2011). 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).

H3: Normative pressure has a positive effect on (a) environmental managerial concern and on (b) environmental performance

Normative pressure is an important external factor, and it can be the result of pressures from different stakeholders on the adoption of eco-innovation (Arnold & Hockerts, 2011; Huang, Ding, & Kao, 2009; Dangelico, 2015). Chen, Chang and Wu (2012) identified the pressure of the environmentalism of investors and clients that require information about firm's actions to mitigate hazardous burdens. Normative pressures can also influence small and medium enterprises (SMEs) (Weng & Lin, 2011) and the adoption of new technologies (Huber, 2008). 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 & Noci, 1998).

Within this context, normative pressure must be given attention and has a great potential to influence environmental performance and environmental managerial concern (Dangelico, 2015). Normative pressures are usually effective, but not always. It did not work in the study from Eiadat *et al.* (2008), as an element to include sustainability into companies' strategy. Similarly, for Qi *et al.* (2010), did not prove a significant effect on construction practices. Normative pressures can also emerge from the need of collaboration among stakeholders due to the need of interaction and interdependencies on different skills and resources that are need for the introduction of an eco-innovation (De Marchi, 2012).

H4: Environmental regulation has a positive effect on (a) environmental managerial concern and on (b) environmental performance

Regulatory pressures have been significant to highlight the importance of environmental policy to prompt eco-innovation (Arnold & Hockerts, 2011) and to cooperate systematically with technological R&D policy (Huber, 2008). The degree of perceived pressure from regulatory stakeholders (Huang *et al.*, 2009) and stricter regulations can boost eco-innovation (Azzone & Noci, 1998; Chen, Chang, & Wu, 2012;

Demirel & Kesidou, 2011; Green, McMeekin, & Irwin, 1994; Horbach, 2008; Horbach, Rammer, & Rennings, 2012; Kesidou & Demirel, 2012; Oltra & Jean, 2009; Qi *et al.*, 2010; Weng & Lin, 2011).

Environmental economics literature emphasizes the key role of environmental policies and regulations to stimulate eco-innovation, since companies may produce creative solutions to adapt to a new scenario (Kesidou & Demirel, 2012). Environmental regulations can be seen as an opportunity rather than just a barrier for companies eco-innovating (Kesidou & Demirel, 2012). Environmental regulations are seen ambiguously from the public, since it is generally accepted, in the sense that everyone wants a good planet to live, but at the same time, reluctant adopted due to the belief that environmental norms will ruin competitiveness **(**Porter & Van Der Linde**,** 1995).

The key role of regulations should make companies turn an obligation in an opportunity to innovate, improve management (positive effect on environmental managerial concern) and adding value to its products and for the company itself (Dangelico, 2015).

H5: Technology has a positive effect on (a) environmental managerial concern and on (b) environmental performance

To respond to a constantly change in technology and to a shorter product's life cycle, companies must increase their investments in environmental innovations to enhance competitive. Likewise, eco-innovation can be a strategy to deal with uncertainty, and technology turbulence can act as influent factors on the level in which the companies adopt eco-innovation through its environmental management increased concern and positively pressuring environmental performance. Turbulences in technology are generated by irresolution of industry technological standards (Han, Kim & Srivastava, 1998). Fast changing technologies can drive companies to increase adoption of eco-innovation (Geffen & Rothenberg, 2000).

H6: Environmental managerial concern has a positive effect on environmental performance

On adoption of eco-innovation it is important to integrate sustainability as an explicit goal in the design process (Arnold & Hockerts, 2011), and managerial environmental concern can be a strong determinant of environmental innovation strategy (Eiadat *et al.*, 2008; Qi *et al.*, 2010). Environmental leadership is a dynamic process in

which one individual influences others to contribute to the achievement of environmental management and eco-innovations (Chen, Chang, & Wu, 2012) and managerial environmental concern (Eiadat *et al.*, 2008) compounds what it is called environmental managerial concern, a central concept in this model.

Top managers' involvement in the innovation process and in the commercialization of innovative products is crucial to reduce risks and barriers for adoption, to integrate technical and market efforts and to enhance the likelihood of success. Strategical and organizational initiatives are important triggers for eco-innovation (Horbach, 2008). Owing to an increasing visibility of leading companies and its managers, environmental managements have been core drivers of sustainable development. Sustainable entrepreneurs and sustainability managers are shaping markets and society substantially (Schaltegger & Wagner, 2011).

Due to normative pressures and risks of being boycotted by consumers and other stakeholders, several companies have included environmental management as part of their strategic plan and of their routine activities. With this, environmental management has become a crucial element of business operation, an important source of good opportunities (Chang & Chen, 2013), and definitely part of management agendas (Chen, 2008).

Having an environmental management as core competency is directly linked to a better performance and to an increasing likelihood for success of an eco-innovation (Chang & Chen, 2013). The achievement of organizational sustainability goals would certainly be facilitated by the presence of an environmental leadership and a visionary management to integrating environmental values into organizational culture, and creating a corporate responsibility (Chen, Chang, & Wu, 2012; Paraschiv *et al.*, 2012).

H7: An environmental managerial concern mediates the relationship between salient drivers for adoption of eco-innovation such as, (a) Environmental capability, (b) Environmental innovation strategy, (c) Normative pressure, (d) Environmental regulation and (e) Technology, and companies' environmental performance.

As stated above, top executives (environmental managerial concern and leadership) should be aware of the opportunities provided by key elements that influence adoption of eco-innovation and enhancement of environmental performance (Dangelico, 2015). Top management is a key driver in companies' strategy, and especially relevant in

realities with ownership's centralization, as in some emerging countries like China (Ding & Jianmu, 2015).

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). To evaluate the impact of the adoption of eco-innovation on firms' business performance, representatives from the food companies were asked to evaluate the performance in terms of sales growth, market share and return on investment (Eiadat *et al.*, 2008). In addition, the degree to which the green innovation could increase environmental and economic performance was also measured (Weng & Ling, 2011).

Environmental managerial concern was finally tested as a mediator due to the relevance of these managers to implement eco-innovation, apply environmental enhancements and increase performance (Eiadat *et al.*, 2008). Eco-innovation adoption as a reaction for regulatory and normative pressures are seen as counter-intuitive, since companies should maximize profits, and eco-innovation introduction can be costly (Eiadat *et al.*, 2008). On the other hand, environmental capability, technology and strategy can push this willingness for increasing environmental reputation and companies' value.

Age is a control variable, since it is alleged that more experienced companies are more capable to better manage its capabilities to successful implement those drivers, adopting eco-innovation and gathering better performance from it (Amores-Salvadó, Martin-de Castro, & Navas-López, 2015). Size was also tested, assuming that bigger companies tend to eco-innovate more, that is, the assumption is that size positively affects willingness to eco-innovate and better perform (De Marchi, 2012).

Having the model and hypotheses that characterized this study being presented, in the next chapter, methodological procedures applied in this thesis are described.

4. METHOD

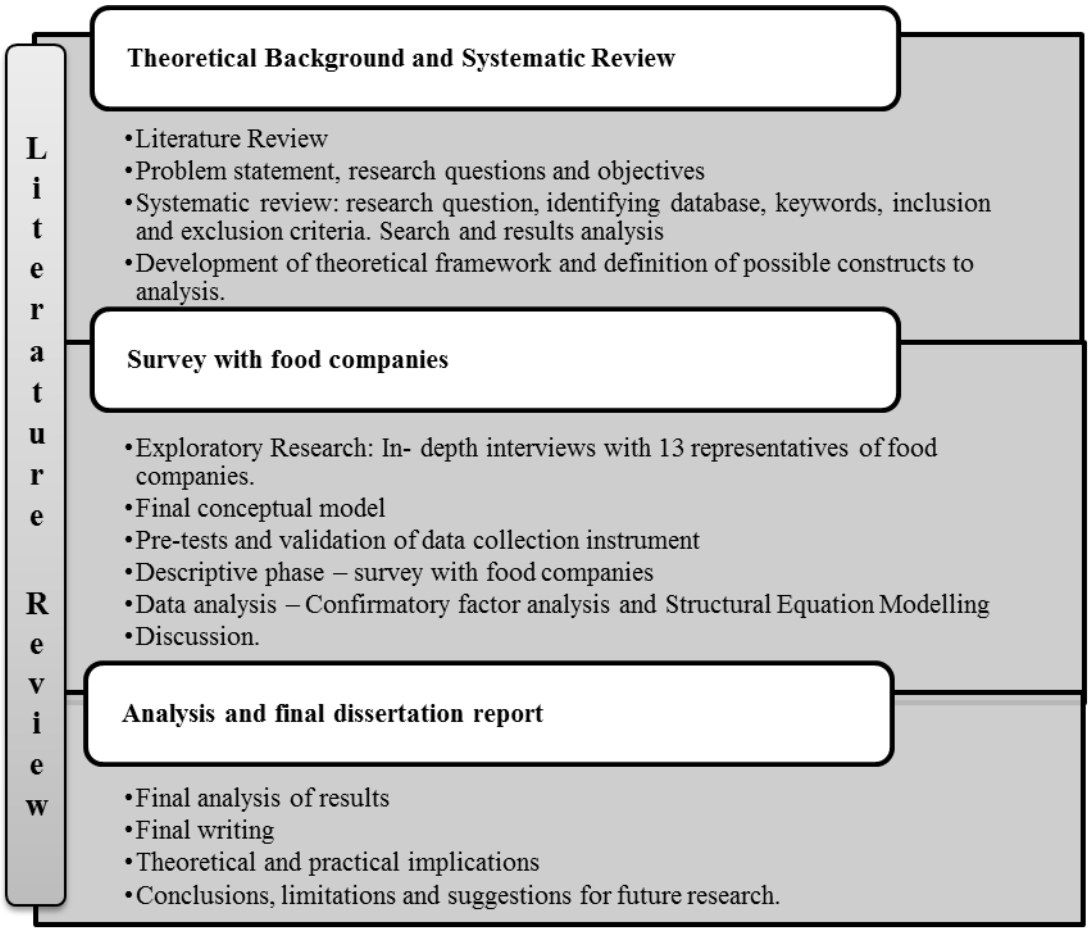
Research in social sciences has been traditionally performed under the application of different methods, in such a way that inferences can be made more accurately. Since the aim of research in this field aims at inferring about behaviour and people or companies` environment, several phenomena must be taken into account (Johnson & Onwuegbuzie, 2004). This study is also based on knowledge built from different sources, data collection and analysis. Methods applied in this study are discussed in this chapter, in which all procedures and stages that have been undertaken are described.

This research started with a thorough literature review on the subject, to develop research background and identifying research gaps. Then, a systematic review to identify main drivers for adoption of eco-innovation was performed, in which was possible to delineate possible constructs for analysis and to build the first theoretical framework (Bossle *et al.*, 2015, 2016). An exploratory phase, with in-depth interviews and pre-tests were also conducted and it was crucial for the development of data collection instrument. Next phase, for testing general and specific goals, and to verify relationships in the theoretical model, a survey was carried out.

This latest phase was classified as descriptive and quantitative. According to Malhotra (2012), descriptive research aims at describing something, usually market characteristics or functions, and must be very well planned. Cross-sectional study is a descriptive design, commonly used, and involves the collection of data from any given sample of population elements only once (Malhotra, 2012, p.62). In this thesis, quantitative data collection was conducted with Brazilian food companies, aiming at testing premises and hypothesis proposed in the model.

Thus, detailed description of each stage is further provided, as follows, and represented in Figure 7.

Figure 7. Research design



4.1 THEORETICAL BACKGROUND AND SYSTEMATIC REVIEW

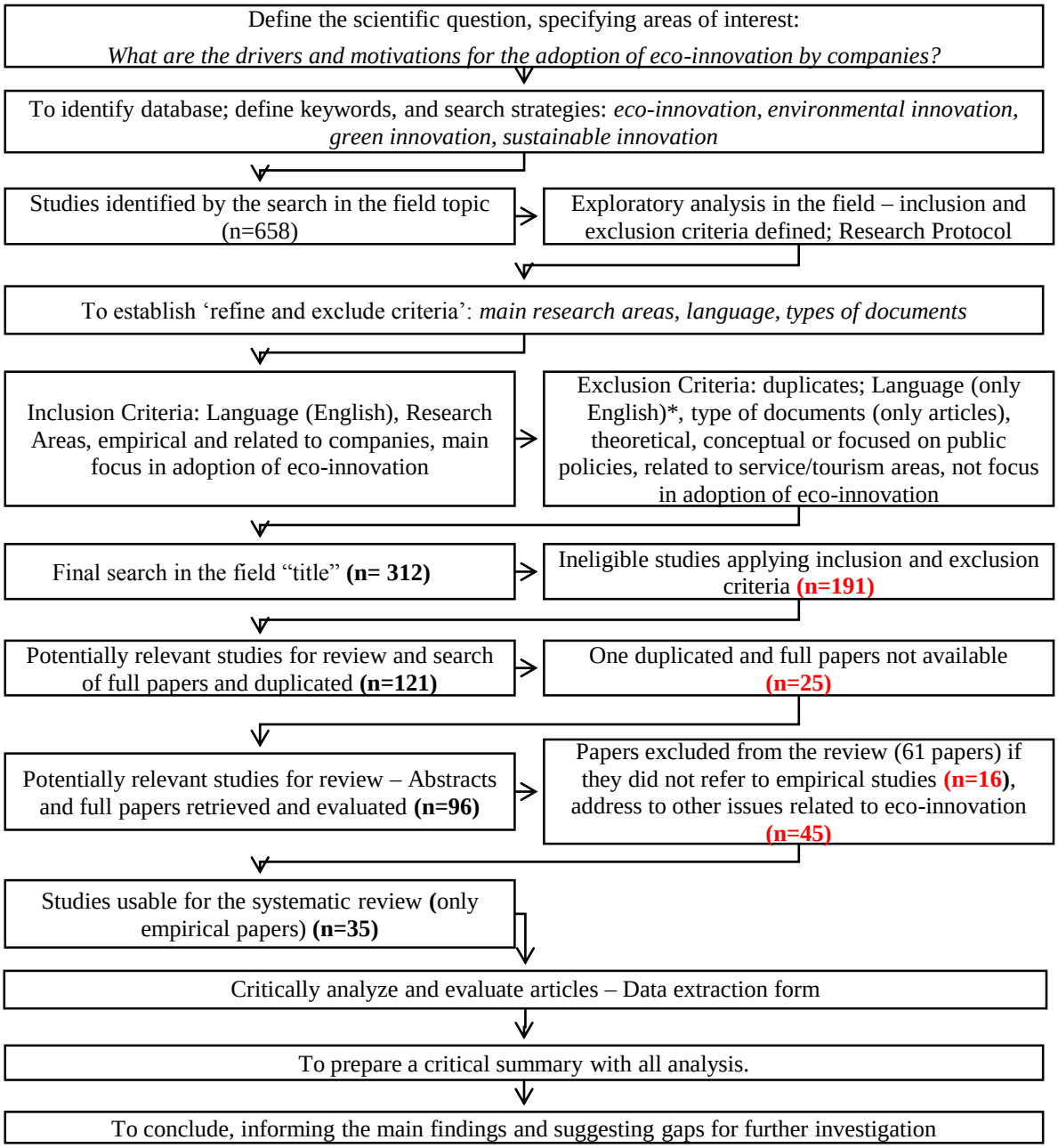
In addition to an extensive literature review, that permeates the whole study, a systematic review in the literature was applied to identify main constructs that could be part of the final conceptual model. This systematic review is under revision at *Journal of Cleaner Production*. In this section, the method applied in this section is described.

A systematic review identifies key scientific contributions to a field, and is traditionally used in medical sciences (Tranfield, Denyer, & Smart, 2003). Systematic reviews are a key source of evidence-based information and can play an important role in helping policy makers interested in evidence-based decision making, since it identifies relevant results that worked for specific interventions (Petticrew & Roberts, 2006). Applying systematic review in management research aims to reinforce results related to tenets and suppositions identified in the literature. Systematic literature review allows the

analysis of a great volume of information, helping to identify constructs or treatments that really works, in a practical point of view (Petticrew & Roberts, 2006).

Literature search process is very systematic, adopting a strict scientific strategy of search that can be replicable and easily understood (Tranfield, Denyer, & Smart, 2003). In Bossle *et al.* (2016), the systematic review followed the protocols outlined by Sampaio and Mancini (2007), Petticrew and Roberts (2006) and Tranfield, Denyer and Smart (2003), and certain methods were refined to adapt to social sciences research. According to Figure 8, 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 (Bossle *et al.*, 2016).

Figure 8. Systematic Review: Design of the research protocol



Source: Bossle *et al.* (2016, p. 864)

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. 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 (Bossle *et al.*, 2016).

Finally, 35 full papers remained in the 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, Denyer, & Smart, 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 (Bossle *et al.*, 2016).

The importance of undertaking a systematic literature review is critical to further understand and assess a new research field (Seuring & 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 (Bossle *et al.*, 2016).

This systematic review was a starting point for identifying drivers for adoption of eco-innovation, final model was refined after a process of validation and exploratory interviews.

4.2 EXPLORATORY RESEARCH

Exploratory research means exactly what its name suggest, to explore and gather more information about a given subject (Malhotra, 2012). Main characteristics of an exploratory research are that information is broadly defined, research process is flexible and non-structured, sample is small and non-representative and primary data analysis is qualitative (Malhotra, 2012). Considering this, this phase mainly included in-depth interviews with eco-innovative food companies` representatives, and validation process for data collection. This phase was crucial for data collection instrument development.

4.2.1 In-depth interviews

Results from this phase were published in Bossle *et al.* (2015a). A qualitative analysis was conducted using a documental survey and 13 in-depth interviews with firms and organizations involved with the eco-innovative food market, green certifications and green food association.

A qualitative research approach is important to obtain deeper information from relevant stakeholders in the food industry. The research protocol consisted of open questions on the following variables: identifying main drivers for eco-innovation, main trends and specific characteristics of this market from their point of view. The interviewees were selected based on their relevance as key stakeholders with different perspectives of the food industry in Brazil, see Table 5 for details. The 13 interviews were recorded and transcribed (Bossle *et al.*, 2015a).

Table 5. Interviewee's characteristics - Supply-side

Interviewee	Business Segment	Details
Ind1	Food Industry: Producer	Organic food for young children
Ind2	Food Industry: Producer and retailer	Agriculture, chicken, convenience products, producer of antibiotic free poultry
Ind3	Food Industry: Producer	Alternative poultry production
Ind4	Food Industry: Producer	Agro ecological Industry - medicinal and food plants
Ind5	Food Industry: Producer	Organic Bread
Ind6	Food Industry: Producer	Producer of biodynamic rice
Ind7	Food Industry: Producer	Organic juice and oils
Ret1	Food retailers	Supermarket specialized in organic, natural, and health products
Ret2	Food retailers	Sustainable food – grocery store and restaurant
Ret3	Food retailers	Organic Tea
Ret4	Food retailers	Organic Food
Cert1	Certifier's organizations	Organic Certification Organization
Cert2	Certifier's organizations	Food Traceability

Source: Bossle *et al.* (2015a)

To analyse the data, the technique of content analysis was applied, in which the content of interviews was divided into the following categories: Companies' motivation to work with eco-innovation, importance of technology in food production, influence of Regulations, and Market, always related to eco-innovative food products (Bossle *et al.*, 2015a).

4.2.2 Validation process – data collection instrument

The process for developing the final version of the conceptual model and validation process of constructs, involved, in addition to the exploratory phase, three phases: assessment of possible constructs to be used in the survey with companies, and two pre-tests.

In this section, the criteria for selection of independent and dependent variable is explained. Literature review undertook in this thesis indicates that there are a great number of variables that could influence the adoption of eco-innovation. Structural equation modelling, the technique chosen for the analysis of this empirical research, is based on causal relationships. The strength of this causation relationship can be assumed and supposed previously according to theoretical justification (Hair *et al.*, 1998,).

All these procedures were followed to avoid a problem known as specification error, that is, to avoid omission of a significant variable (Hair *et al.*, 1998). At the same time, including all variables has practical limitations, not only because the number of variables will be large, but also to recognise the benefits of parsimonious and concise theoretical models (Hair *et al.*, 1998, p. 594).

First, to evaluate the proposed framework and constructs proposed in Bossle *et al.* (2016), an empirical test was carried out in September 2014 with practitioners and academic experts from the food sector. The sample was composed by 24 professionals: practitioners (n=14), such as directors and managers of R&D department; by representatives of sectorial institutions (n=7), e.g. directors, analysts and managers; and academic researchers (n=3), e.g. Post-doc and PhD students, experts in the food sector. Drivers (see Table 6) were presented to respondents with the corresponding description, and they were asked to assess to what extent each of the factors was important to influence the adoption of eco-innovation. A 10 point scale was used, from 'Not important at all' (1) to 'Extremely important' (10) (Bossle *et al.*, 2015b).

Table 6. Relevance of factors according to professionals from the food sector

Factors	N	Min.	Max.	Mean	Std. Dev.
Prospect of expanding market	21	7	10	8.86	1.1952
Environmental culture	24	6	10	8.75	0.9441
Environmental capability	24	7	10	8.54	1.0624
Market demand -Stakeholders' pressure	24	4	10	8.50	1.7693
Quality and participation of human resources	23	2	10	8.17	1.8745
Environmental leadership	24	5	10	8.17	1.4346
Environmental managerial concerns	24	4	10	8.13	1.5411
Cooperation	24	5	10	8.00	1.3513
Efficiency	24	3	10	8.00	1.588
Regulatory pressures	24	2	10	7.92	2.4302
Adoption of certifications	24	3	10	7.83	1.633
Public financing	24	3	10	7.63	1.9068
Performance	23	2	10	7.61	2.3691
The role of governments	24	3	10	7.04	1.9444
Sector	24	1	10	6.75	2.9378
Firm's size	24	2	10	5.46	2.7184
Valid N (listwise)	19				

Source: Bossle *et al.* (2015b)

According to the results, professionals from the food sector ratified the findings in the literature for the relevance of the given factors, which allows a preliminary approval of the developed framework. Since we assessed perception from different stakeholders, we conducted an ANOVA test for verifying if there were any differences among groups towards drivers' evaluation. We only found differences regarding the perception towards the influence of 'Regulatory Pressures' (p=0.009) and 'Prospect of expanding market' (p=0.005). Practitioners evaluated 'Regulatory Pressures' (6,71) and 'Prospect of expanding market' (7,0) as less important than representatives of sectorial institutions (9,71; 8,2) and academics (9,33; 9,36) (Bossle *et al.*, 2015b).

Following this phase, a preliminary version of questionnaire could be built, and two pre-tests were performed. Pre-test is a questionnaire test, and the aim is to identify and eliminate potential problems. Every single aspect in the questionnaire must be evaluated, content, writing, sequence, layout, if questions and instructions are comprehensive. In addition, pre-test should be applied in person, no matter how the final survey will be run, so the interviewer can test respondents` reaction (Malhotra, 2012).

According to these guidelines, first a pre-test was conducted in October 2014 at SIAL, France, in two versions, in Portuguese and in English. SIAL, The Global Food Marketplace, is the world's largest food exhibition that took place in Paris in November 2014. Eight interviews were carried out, six in Portuguese and two in English. Analysis from the results of this first test, both from results and from respondents` comments and

reactions allowed several improvements in the questionnaire. Some questions were rewritten to make it clearer, inverse questions were change to direct, mainly due to the aim of applying with a Brazilian sample, that does not respond well for this kind of questions. In additions, some scales were revised, and replaced.

Having a second version of the questionnaire, a second pre-test were conducted in Porto Alegre at BioNat Expo, a trade fair with organic, sustainable and solidarity economy products, in person. At this fair, since most of exhibitors from the food sector were small organic producers, it was found a lack of knowledge with the term eco-innovation and even some resistance. This drawn attention to the need of better explain the concept, so the eco-innovation definition was rewritten for the final version and more elements to the filter question were added, to better identify eco-innovators. After conducting 13 interviews, the questionnaire was improved to achieve its final form in January 2015.

4.3 DESCRIPTIVE PHASE - SURVEY WITH COMPANIES

Descriptive research aims at describing characteristics of relevant groups, such as organizations, to estimate the percentage of units in a population that exhibits a given behaviour, to make specific predictions, and to determine how and to which degree variables are associated (Malhotra, 2012). Data collection instrument used in this survey is a result of the previous procedures, that is, exploratory research (secondary data and interviews), and validation process. A survey is commonly defined as a method of gathering information from a sample of individuals. “Sample means a fraction of the population, and collection of information is made by very homogenous procedures, in which every individual is asked same questions in the same way” (Scheuren, 2004, p. 9).

This method was applied to test the proposed model, through testing the hypothesis developed for this study through the technique of structural equation modelling. The aim was to verify empirical causal relationships among given drivers for adoption of eco-innovation and the enhancement of performance in Brazilian food companies. The quantitative data from this stage was analysed with SPSS (Univariate statistics) and Amos (Multivariate statistics - SEM).

Next, variables and constructs meanings are elucidated followed by description of measures and constructs.

4.3.1 Variable and construct

In structural equation modelling (SEM), there are two general types of variables, observed (also called manifest and indicator) and latent (also called factors or constructs), in addition to another type, that corresponds to residual or error terms (Kline, 2011). A construct refers to "a concept that can be defined in conceptual terms, but cannot be directly measured" (Hair *et al.*, 1998, p. 579). This means that respondents need to answer for a set of questions (each question correspond to an indicator, or observed variable) to allow inferences on its perception in regard to the construct. Construct are the basis for formal causal relationships, and can be narrow concepts, such as income or companies` size or more complex, such as emotions or environmental capability (Hair *et al.*, 1998).

4.3.2 Data collection, population and sample

Targeted population for this study are food companies that develop eco-innovation. Since eco-innovation is not a certification, but rather a concept, and very recent, there are no data in relation to the population of companies within this profile. Therefore, the questionnaire had a clear explanation of the meaning used in the study for eco-innovation, followed by a main filter question, and a set of questions to decide if the company fitted on the targeted group for this survey. Companies were then selected through industrial associations' databases, such as the one from the Federation of Industries of Rio Grande do Sul (FIERGS) and certification bodies such as IBD organic, Ecocert and Rainforest Alliance.

The sample size plays a key role for analysing data through structural equation modelling, and as in any other quantitative method, providing basis for the estimation of sampling error (Hair *et al.*, 1998, p. 604). It is known that a big sample is needed, but it is not a consensus how big it must be, and there are many factors impacting in this decision (Hair *et al.*, 1998; Kline, 2011). Sample size will also depend on the number of parameters the model is due to estimate, the larger the model, the larger must be the sample to warrant stable results (Kline, 2011). Hair *et al.* (1998) recommends at least a sample size of 200, with increases in case of misspecification, large or complex models, non-normal data or the use of alternative estimation procedure.

In this study, data collection was carried out through a telephone survey with 581 food companies and the collection process was performed from January to April 2015. In

total, databases comprised 1647 companies, sample represent around 35% of the total amount of available companies. Another issue regarding this sample is that it is characterized as a simple random sample. That is, every element from the population has the same probability of being chosen, as well as every combination of possible samples has the same probability of being chosen (Malhotra, 2012). For these, all companies from different databases were mixed and id numbers were randomly assigned for each company allowing the random selection, rather than any other previous order in original databases.

Respondents were targeted according to their position in the company, e.g. owner, director, top managers from environmental or product development. It means that respondents necessarily needed to have knowledge about the decision-making process and new product development process. Table 7 identifies respondents` position within the company:

Table 7. Respondents` position

Position within the company	n	%
Quality management	176	34%
Management employees (supervisors, coordinators, assistant managers, analysts - quality, development, production)	147	28%
Owner, president, shareholder, business partner	123	23%
Managers, directors (environmental, quality, administrative, production)	54	10%
Others, nonspecified	13	2%
Non management employees (Commercial department, secretary, office assistant)	12	2%
Total	525	100%

Most companies were from South Region (370), followed by South-east (115), and other regions (40). The oldest company was established in 1815 and the newest in 2014, with more than 240 established after 1995. In relation to firm revenues in 2013, 201 companies won R$ 2.4 million or less, 150 between R$ 2.4 and R$ 16 million, 121 between R$ 16 and R$ 90 million, 30 between R$ 90 and R$ 300 million and 10 more than R$ 300 million. Thirteen companies didn't answer this question. More details in relation to companies` characteristics will be provided in the next chapter.

4.3.3 Questionnaire

The applied questionnaire was organised in four parts. First, after an introduction about the subject and the research, one main filter question was posed after the eco-

innovation definition. Specifically, respondent was asked if the company fitted in the given definition. Since our aim was to investigate companies with these characteristics, more questions were conducted in that sense, to make sure that companies were within the targeted group. So, respondents were posed more fourteen yes/no questions to define what kind of action was performed in relation to eco-innovations.

Eco-innovation was defined in the questionnaire as follows: "*Eco-innovation (Environmental, Sustainable, or Green Innovation) is the development or implementation of (new) products, process or services that creates environmental benefits. Eco-innovation can be achieved with concerns with basic ingredients (organic, free range), packaging (i.e. recyclable), manufacturing process (energy saving, water recycling), logistics or distribution (new channels or direct consumer sales etc); certifications (traceability or origin, eco-labels, fair and solidarity trade, ISO 14001); commercial aspects (low carbon footprint, etc.)*".

Following this first part, that was actually eliminatory, respondents were asked about their perceptions in relation to external and internal forces that could influence the company on adoption of eco-innovation. Then, items related to performance, management and company's characteristics were also investigated.

4.3.4 Definition of measures and constructs

Final version of the questionnaire comprised the following constructs: environmental capability, strategy, and environmental managerial concern, pressure of environmental regulations, normative pressure, technology turbulence and perception of performance from adoption of eco-innovation. In addition, other constructs were measured, but not included in the analysed model, i.e. the importance of human resources, influence of cooperation, government support and top management risk aversion, for reasons that will be further explained.

To measure environmental capability, four items from Chen (2011) and Chen *et al.* (2012) were used. Eight items from Chen (2011), Chen *et al.* (2012) and Eiadat *et al.* (2008) measured managerial environmental concern (that includes environmental leadership). All items were measured by means of "five-point Likert scale from 1 to 5" rating from strongly disagreement to strongly agreement.

To evaluate if environmental innovation is included in the companies' strategy, a four-item instrument on environmental strategy used by Chen *et al.* (2014), adapted from

Banerjee *et al.* (2003) was used. Measurements ranged from strongly disagree to strongly agree, in a five-point Likert.

Measures for the construct "pressure of environmental regulations" were taken from The Community Innovation Survey (The Community Innovation Survey - CIS, 2008), and from Eiadat *et al.* (2008), in a "five-point Likert scale from 1 to 5" ranging from strongly disagreement to strongly agreement.

Normative pressure was measured using similar scales from OECD survey on Environmental Policy and Firm-level Management, that surveyed the link between government environmental policies and environmental management, investments, innovation and performance (Arundel & Kemp, 2009), CIS (2008) and Huang *et al.* (2009), since they brought a complete range of stakeholders. Representatives from companies were asked to state the importance of the influence of different stakeholders, individuals or groups, on the adoption of eco-innovation by the company in a 5-point Likert ranged from "not important at all" to "Very important".

To evaluate the impact of the adoption of eco-innovation on firms' business performance, representatives from the food companies were asked to evaluate the performance in terms of sales growth, market share and return on investment (Eiadat et al, 2008). In addition, the degree to which the green innovation could increase environmental and economic performance was also measured using two items from Weng and Ling (2011), ranging from "substantial negative" (1) and "substantial positive" (5).

Technological turbulence items appointed the extent to which technology in an industry was in a state of change. Scales were borrowed by Jaworski and Kohli (1993), also used in Calantone *et al.* (2003) and Han, Kim and Srivastava (1998). Table 8 presents constructs, items, sources and scales used in the final model of this thesis.

Table 8. Constructs, scales and sources – final model

Construct	Items	Scales and sources
Environmental capability	The company's abilities to integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations are…..	Chen (2011) and Chen *et al.* (2012)
	Outstanding. (EC1) Rare in marketplace. (EC2) Less imitable by competitors. (EC3) Difficult to be substituted. (EC4)	five-point Likert scale from strongly disagree (1) to strongly agree (5)

Environmental strategy	Our firm has integrated environmental issues into our strategic planning process. (ST1) At our firm, quality includes reducing the environmental impact of products and processes. (ST2) At our firm we make every effort to link environmental objectives with our other corporate goals. (ST3) Environmental issues are always considered when we develop new products. (ST4)	Chen *et al.* (2014), adapted from Banerjee *et al.* (2003) five-point Likert scale from strongly disagree (1) to strongly agree (5)
Environmental regulations	Recently my company introduced an eco-innovation in response to existing environmental regulations or environmental taxes. (ER1) Recently my company introduced an eco-innovation in response to environmental regulations or taxes that are expected to be introduced in the future. (ER2)	CIS (2008) five-point Likert scale from strongly disagree (1) to strongly agree (5)
	Environmental laws and regulations that impact my company contain stringent standards. (ER3) Environmental laws and regulations that impact my company are appropriate for my country's circumstances. (ER4) Environmental laws and regulations that impact my company are clear. (ER5) Environmental laws and regulations that impact my company are effective in tackling environmental problems directly. (ER6)	Eiadat *et al.* (2008) five-point Likert scale from strongly disagree (1) to strongly agree (5)
Normative Pressure	**The importance of the demand/pressure from (….groups below….) for adoption of eco-innovation was:** From Public authorities (government, state, municipal) (NP1) From Corporate headquarters (NP2) From Household consumers/clients (NP3) From Commercial buyers (NP4) From Suppliers of goods and services (NP5) From Shareholders and investment funds (NP6) From Banks and other lenders (NP7) From Management employees (Top executives; Top Managers) (NP8) From Non-management employees (Employees) (NP9) From Labour unions (NP10) From Industry or trade associations (NP11) From Environmental groups or organisations (NP12) From Neighbourhood/community groups & organisations (NP13) From Competitors (NP14) From International partners (NP15)	Arundel & Kemp, (2009), CIS (2008) and Huang *et al.* (2009) five-point Likert ranged from Not important at all (1) to Very important (5).
Technology turbulence	The technology in our industry is changing rapidly. (T1) Technological changes provide big opportunities in our industry. (T2) It is very difficult to forecast where the technology in our industry will be in the next 2 to 3 years. (T3) A large number of new product ideas have been made possible through technological breakthroughs in our industry. (T4) Technological developments in our industry are rather major. (T5)	Jaworski and Kohli (1993), also used in Calantone *et al.* (2003) and Han, Kim and Srivastava (1998). five-point Likert scale from strongly disagree (1) to strongly agree (5)
Managerial environmental concern	The leaders within the company inspire a shared vision of the organization as environmentally sustainable, creating or maintaining green values throughout the company. (EMC1) The leaders within the company utilize well-developed approaches to environmental management which generally center around a program customized to the company's specific business and market. (EMC2)	Chen (2011), Chen *et al.* (2012) five-point Likert scale from strongly disagree (1) to strongly agree (5)

	The leaders within the company create partnerships with the company's stakeholders to solve environmental problems and to accomplish environmental goals. (EMC3) The leaders within the company can take on the responsibility of environmental education with the intent of engaging employees in environmental management initiatives. (EMC4)	
	Environmental innovation is necessary to achieve high levels of environmental performance. (EMC5) Environmental innovation is an important component of the company's environmental management strategy. (EMC6) Most environmental innovations are worthwhile. (EMC7) Environmental innovation is an effective environmental management strategy. (EMC8)	Eiadat *et al.* (2008) five-point Likert scale from strongly disagree (1) to strongly agree (5)
Performance	The effect of the adoption of eco-innovation on market share was... (P1) The effect of the adoption of eco-innovation on sales growth was... (P2) The effect of the adoption of eco-innovation on return on investment was…. (P3)	Eiadat et al, 2008 five-point Likert scale from "substantial negative" (1) and "substantial positive" (5).
	The effect of the adoption of eco-innovation on environmental performance was…. (P4) The effect of the adoption of eco-innovation on economic performance was…. (P5)	Weng and Ling (2011) - five-point Likert scale from "substantial negative" (1) and "substantial positive" (5).

Finally, general information from the company was assessed, such as size, age, turnover, investments in R&D, overall performance, etc.

Other variables were measured, but did not compose the final model are presented here. The importance of human resources to prompt companies to develop eco-innovation was assessed with four items developed by Green *et al.* (1994) and Weng and Lin (2011), in a 5-point Likert scale ranging from "not important at all" to "very important". Questions included personnel commitment to environmental matters, motivation and training for sustainability approach, and top management encouragement for employees (Weng & Lin, 2011).

To assess the influence of cooperation, respondents were asked to state the level of collaboration with different groups. Both for boosting the adoption eco-innovation (De Marchi, 2012; Green *et al.*, 1994) and to gather information for the development and adoption (The Community Innovation Survey - CIS, 2010) from "not important at all" (1) to "very important" (5).

Governmental support was measured by whether the government provides financial and technical supports for adopting green innovations in a 3-items scale from Weng and Lin (2011), ranging from not at all (1) and to a great extent (5). Following the

scale used by Jaworski and Kohli (1993) and Calantone et al (2003), top management risk aversion were assessed.

4.4 DATA PREPARATION

Before starting data analysis, it is essential to perform data screening for checking and avoiding important problems that can ruin the study (Kline, 2011). Structural equation modelling assumes some premises, and therefore data must be checked for missing values, outliers and normality tests. West, Finch and Curran (1995) draw attention to the fact that to undertake accurate models using structural equation modelling is crucial to satisfy some principles, such as multivariate normal distribution, among others. Potential problems in estimation of structural equation models are introduced when the distribution of observed variables departs substantially from multivariate normality (West, Finch and Curran, 1995). Considering this, data were checked for all these principles. Kline (2011, p.63) considers variables with extreme skewness, those with an absolute value higher than 3, and kurtosis over 8.

It is known that missing data must be addressed in structural equation modelling; although it is not a clear topic when time to decide how to analyse it has come (Kline, 2011). Ideally, researchers should always work with complete datasets, but missing data in a multivariate analysis is a fact of life, and the main concern must be in understanding why it happened (Hair *et al.*, 1998; Kline, 2011). A small number of missing values, random and not systematic are of little concern, such as less than 5% on a single variable in large datasets (Kline, 2011).

After cleaning the database for duplicates, cases with data collection problems, and companies from other sectors (17), the database remained with 564 cases. In the first analysis, one questionnaire was deleted since each of them just answered yes to one of the 14 filter questions (q1). Then, a transposed matrix was generated in order to identify inconsistencies in responses, such as all responses in the same number, or only in 4 and 5 or 1 and 2. That is, the aim of this analysis was to identify respondents that used only one or two scales for answering. Two questionnaires were deleted (only answers 4 and 5 for all questionnaire).

Outliers are observations that are substantially different from others, with extreme values that cannot be classified as beneficial or problematic without a contextual analysis

(Hair *et al.*, 1998). Considering the multivariate perspective of this study, a multivariate assessment was also performed, through Malahanobis D^2. This measure allows the assessment of the distance in multidimensional space of each observation with the mean centre of the observations (Hair *et al.*, 1998, p. 66). Cases with a significance less than 0.001 should be considered as outliers and be eliminated. In this analysis, nine cases were considered multivariate outliers and removed from database, remaining 552 cases.

Missing values were also analysed. By analysing questions 2 to 11, none of the variables presented more than 2.6% of missing values. When analysing the cases, twenty-seven cases were eliminated since they presented more than two missing values in the same question. Cases with only one missing value were kept, and the missing value was replaced by series mean. Series means imputation, in which missing value is replaced with the mean value of that variable based in all valid answers is one of the more commonly used methods (Hair *et al.*, 1998). Final database remained with 525 companies.

4.5 DATA ANALYSIS

Structural equation modelling is a procedure to estimate causal relationships, that is a series of separate, but interdependent, multiple regression equations simultaneously by specifying the structural model. Principles from Regression analysis and Factorial analysis are the basis for SEM, the idea is that there is the theoretical development of a model, stating all possible relationships, that is, which independent variables predict each dependent and then, validation with SEM (Hair *et al.*, 1998; Malhotra, 2012).

Reliability is also a concern in multivariate techniques and therefore, error-free would be the ideal situation, I which prediction is perfectly fitted with structural coefficient. However, it is known from theoretical and practical perspective that there is always some degree of measurement model, and the aim is to minimize this error (Hair *et al.*, 1998). Measurement errors are not just caused by inaccurate responses, but can be caused by the use of complex or abstract concepts (Hair *et al.*, 1998).

Structural equation modelling is also called analysis of covariance structures, analysis of latent variables and causal modelling (Hair *et al.*, 1998; Malhotra, 2012) and takes a confirmatory approach to the data analysis, rather than exploratory (Byrne, 2010; Malhotra, 2012). For accounting the measurement error, the measurement model must be built and analysed. In SEM, there is the explicit incorporation of the measurement error,

by adding strategies and estimation methods accordingly (Malhotra, 2012), improving accuracy on the estimation of the structural model (Byrne, 2010).

Data analysis in SEM is based on covariance or correlation matrix analysis, instead of observed raw data. Covariance matrix is adequate when the researcher aims at testing a theory, with the main goal at validating causal relations since this matrix indicates the total variance of the constructs involved in the model (Hair *et al.*, 1998). Therefore, to generate the covariance matrix, data collected was treated with procedures to verify quality of answer and treatment of any discrepancies that could harm statistical tests to be applied (Hair *et al.*, 1998).

As previously stated, some assumptions must be fulfilled for the accuracy of analysis in SEM. Data must comply with univariate and multivariate normality, that was assessed in this sample. Different estimated methods can be used, the most common is Maximum likelihood estimation (MLE), used in this analysis. Amos, the software used for SEM, calculates asymmetry indices and Mardia coefficient (Pilati and Laros, 2007). Other assumptions are related to outliers, in addition to homoscedasticity and heteroscedasticity (Kline, 2011).

Some important concepts for SEM are confirmatory factor analysis (CFA), endogenous and exogenous construct, measurement and structural model (Malhotra, 2012). Confirmatory factor analysis is the technique used to estimate the measurement model. The main aim is to confirm if the factors (constructs) will correlate, and if the number of factors and observed variables factor loadings behave as it is expected from theory (Malhotra, 2012). Exogenous variables are equivalent to independent variable, and they cause fluctuations in the values of other latent (endogenous, dependent) variables in the model (Byrne, 2010, p. 5).

Structural equation modelling must be based on a theory, so the most direct application of SEM is confirmatory modelling strategy. SEM consists of two models, measurement and structural model. Measurement model uses CFA and serves to confirm if observed variables are explaining the construct, and validity of this construct is assessed.

Structural model defines relations among the unobserved variables, that is, among constructs. It specifies how a particular latent (dependent, endogenous) variable directly or indirectly influences changes in other latent variable in the model (Byrne, 2010, p. 13).

Following the presentation of the method, we present the results in the next chapter.

5. RESULTS

"Human kind cannot bear very much reality."

T. S. Elliot

"Les hommes ont toujours lutté de toutes leur forces contre la realité."

Jean Servier.

In this chapter, results from the descriptive phase are discussed. Results from the exploratory research can be further seen in Bossle *et al.* (2015a). First, sample characterization is untaken, followed by univariate statistics, with means and frequencies, and finally multivariate analysis, with structural equation modelling analysis.

5.1 DESCRIPTIVE ANALYSIS

5.1.1 Companies' Profile – sample characteristics

Considering 525 companies in the final database, in this section, their profile is unveiled and investigated characteristics are presented. In this study, respondents were asked about general features, such as, size, year of establishment, economic profits, revenue, certifications, and position within the company among others. In relation to companies` location in Brazil, most companies were from South Region (370), followed by South-east (115), and other regions (40), see Table 9. Although these numbers are not representative, they are quite important due to the relevance of these six states that comprises south and south-east region.

São Paulo, Rio de Janeiro, Minas Gerais, Rio Grande do Sul, Santa Catarina e Paraná are responsible for more than 85% of people employed in the industry, what represents more than 20 million people in 2013 (CNI, 2014). These two regions are responsible for 76.9% of total Brazilian Gross Domestic Product (GDP), being south-east alone representing 60.6% (CNI, 2014).

Table 9. Companies` location

Region and state	Number of Companies
South	**370**
RS	336
PR	19
SC	15
South-East	**115**
SP	67
MG	42
RJ	6
Other States (BA, CE, DF, PA, GO, PI, MT, PB, AC, AL, AM, AP)	**40**

Revenue in 2013 was also investigated since it can reveal about company`s size, according to BNDES (2010). Companies that won R$ 2.4 million or less are considered micro, between R$ 2.4 and R$ 16 million, small, between R$ 16 and R$ 90 million, medium, between R$ 90 and R$ 300 million, medium-large, and more than R$ 300 million are considered large. As can be observed in Table 10, most of the companies are micro, small or medium enterprises. When it concerns to companies financial wealth, it can be seen that most of food companies in this sample are quite profitable, with only 7% presenting losses within the past three years.

Table 10. Revenue and economic performance

Revenue	**Number of companies**	**%**
R$ 2,4 million or less	201	38%
More than R$ 2,4 million up to R$ 16 million	150	29%
More than R$ 16 million up to R$ 90 million	121	23%
More than R$ 90 million up to R$ 300 million	30	6%
More than R$ 300 million	10	2%
Total	**512**	
Missing Values	*13*	*2%*
Economic performance	**Number of companies**	**%**
Revenue has been so low as to produce large losses.	3	1%
Revenue has been insufficient to cover costs.	32	6%
Revenue has allowed us to break even.	90	17%
Revenue has been sufficient to make a small profit.	220	42%
Revenue has been well in excess of costs.	174	33%
Total	**519**	
Missing Values	*6*	*1%*

In relation to age, the oldest company was established in 1815 and the newest in 2014, as can be seen in Table 11. In relation to number of employees, the sample is quite distributed, with 76% of companies with less than 200 employees. Although companies

were classified as eco-innovators, only 48% stated that the company has an environmental certification. Apparently, Brazilian food industry are still not aware of the importance on adopting eco-labels, maybe due to lack of pressure from both suppliers, consumers and government.

Table 11. Age and number of employees

Foundation year	**Number of companies**	**%**
1815 – 1970	129	25%
1971 – 1990	122	23%
1991 – 2000	146	28%
2001 – 2014	128	24%
Total	**525**	**100%**
Number of employees	**Number of companies**	**%**
Less than 15	114	22%
More than 15 up to 49	145	28%
More than 50 up to 200	137	26%
More than 200	119	23%
Total	**515**	
Missing Values	*10*	*2%*
Environmental Certification	**Number of companies**	**%**
Yes	252	48%
No	273	52%
Total	**525**	

5.1.2 Univariate Statistics

As an introductory phase for Structural Equation modelling, general characteristics of the sample must be described for each variable, in order to assess indicators for normality, linearity and collinearity (Prado, 2006). That is, it is important to present mean, standard-deviation and indicators of kurtosis and skewness for every variable in the model (Prado, 2006).

In relation to collinearity, that is, the relationship between two (collinearity) or more (multicollinnearity) variables (Hair *et al.*, 1995, p. 218) all variables were tested.

Considering the stated concept for eco-innovation and the second filter question, which consisted on a list of actions to identify what kind of environmental practices companies undertaken, Table 12 shows the results. As can be seen, companies in this sample introduced or implemented innovations aiming at pollution reduction in air, water, noise or soil (n=456) and managing and recycling waste, water and materials (n=429). A great number of companies uses environmental reports to communicate about its practices (n=397), replace materials with less polluting alternatives (n=351) and adopt recyclable or ecological practices (n=327).

Companies are therefore taking some strategies to reduce their impact on the environment and increasing its efficiency, taking advantage of innovation and sustainability concepts to acquire a status of environmental responsible (Korhonen, 2001) and at the same time, addressing specific problematic areas (Rennings, 2000). Labelling and a good communication strategy (Arnold & Hockerts, 2011), adopting information and communication technologies (Cainelli; Mazzanti; Montresor, 2012), as well as to adopt environmental certification practices, such as ISO 14001, represent an important starting point for the introduction of pro-active environmental practices (Azzone & Noci, 1998).

Table 12. Filter Question frequencies

Did your company introduce or implement one or some of the following innovation with environmental benefits?	**Yes**	**No**	**N**
Reduction of water, air, soil or noise pollution within my enterprise	456	69	525
Management and Recycling waste, water, or materials within my enterprise	429	96	525
Adoption / elaboration of environmental reports	397	128	525
Replacement of materials with less polluting or hazardous substitutes within my enterprise	351	174	525
Adoption of recyclable or ecological packaging	327	198	525
Sustainable distribution channels	314	211	525
Adoption of traceability or origin labelling	309	216	525
Adoption of certification (organic, bio, Demeter, biodynamic)	295	230	525
Reduction of material use per unit of output within my enterprise	264	261	525
Reduction of energy use per unit of output within my enterprise/adoption of renewable energy	253	272	525
Reduction of CO2 ‘footprint’ (reduction of total CO2 production) by my enterprise	210	315	525
Selling or production of Fair and solidarity products	200	325	525
Environmental Management and auditing systems E.g.: EMAs and ISO 14001.	125	400	525
Production of meat and/or eggs from free range animals	55	470	525

Environmental Capability, that measured companies’ capabilities to deal with environmental management and innovations, in a 5-point scale ranging from strongly disagree (1) to strongly agree (5) presented a satisfactory reliability (alpha=0,898). Due to low means of items in this construct (around 3.00), it can be inferred that companies analysed are not very confident in relation to its environmental capability, even if awareness seems to be high, as well as the adoption of eco-innovation. That means that companies are not entirely under conditions to use its internal competency to coordinate

skills, resources and technologies towards a more environmental management. An enhancement on environmental capability can be extremely relevant for companies to raise their eco-innovation performance, considering that this ability is advantageous for the development of eco-innovations (Chen, Chang, & Wu, 2012).

Table 13. Environmental Capability - univariate statistics

The company's abilities to integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations are…..	Mean	Std. Dev.	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
Outstanding. (EC1)	3,3	1,13	-0,48	0,107	-0,427	0,213
Difficult to be substituted. (EC4)	2,91	1,174	-0,167	0,107	-0,836	0,213
Rare in marketplace. (EC2)	2,9	1,14	-0,092	0,107	-0,667	0,213
Less imitable by competitors. (EC3)	2,74	1,186	0,045	0,107	-0,839	0,213
Cronbach's alpha (n=525; 4 items)	*0,898*					

Environmental strategy, measured with 1-5 scales (strongly disagree to strongly agree) presented an internal consistency (alpha=0,927) and high means for all items. Companies in this sample claimed that the inclusion of environmental concerns in their strategy is a current practice. Companies state that they integrated environmental issues to the new products development process (4,11), see Table 14. This result is quite encouraging, given the importance of applying eco-innovation in the strategy of the firm and developing a structured and long-term oriented management of sustainability innovations (Arnold and Hockerts, 2011). Santini, Cavicchi and Casini (2013) also supports the importance of incorporate sustainability in the company's strategy.

Table 14. Environmental strategy - univariate statistics

	Mean	Std. Dev.	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
Environmental issues are always considered when we develop new products. (ST4)	4,11	0,88	-0,726	0,107	-0,102	0,213
At our firm we make every effort to link environmental objectives with our other corporate goals. (ST3)	4,08	0,857	-0,539	0,107	-0,574	0,213
At our firm, quality includes reducing the environmental impact of products and processes. (ST2)	4,07	0,869	-0,641	0,107	-0,08	0,213
Our firm has integrated environmental issues into our strategic planning process. (ST1)	4,04	0,92	-0,601	0,107	-0,522	0,213
Cronbach's alpha (n=525; 4 items)	*0,927*					

Environmental regulations (Table 15), usually the most important factor for adoption of eco-innovation was important in this study, but not the most imperative factor in magnitude. Measured in terms of 5-point scale, from strongly disagree (1) to strongly

agree (5), presented internal consistency (alpha=0,836), and highest mean for the item that states the efficacy of environmental regulation (4,09). Companies also seems to not be very concerned with anticipated strategies, since the lowest mean is for the item that ask if an eco-innovation was introduced as a response to regulations that are expected to be introduced (3,63).

This result should be stressed as a particular characteristic of Brazilian companies, and the reality in other developing and emerging countries. As indicated by Ashford (2002), government intervention and regulations can be weaker in developing countries and this can explain the less relevant magnitude of influence from these policies when comparing to other drivers (Ashford, 2002).

Table 15. Environmental regulations – univariate statistics

	Mean	**Std. Dev.**	**Skewness Statistic**	**Std. Error**	**Kurtosis Statistic**	**Std. Error**
Environmental laws and regulations that impact my company are effective in tackling environmental problems directly. (ER6)	4,09	,809	-,712	,107	,364	,213
Environmental laws and regulations that impact my company contain stringent standards. (ER3)	4,03	,887	-,623	,107	-,151	,213
Environmental laws and regulations that impact my company are clear. (ER5)	3,96	,961	-,716	,107	-,059	,213
Environmental laws and regulations that impact my company are appropriate for my country's circumstances. (ER4)	3,94	,873	-,586	,107	,074	,213
Recently my company introduced an eco-innovation in response to existing environmental regulations or environmental taxes. (ER1)	3,82	,984	-,528	,107	-,401	,213
Recently my company introduced an eco-innovation in response to environmental regulations or taxes that are expected to be introduced in the future. (ER2)	3,63	,929	-,357	,107	-,210	,213
Cronbach's alpha (n=525; 6 items)	*0,836*					

As can be seen in Table 16, normative pressure is a very large question with 15 items, and it had to be cleaned for final analysis, also because some of the items would affect normality due to high kurtosis and skewness statistics. In general, stakeholders with direct and internal influence on the company were those with a stronger perceived importance. Scale ranged from 1 to 5, where 1 means not important at all and 5, very important. Importance from top executives (4,66), public authorities (4,63), corporate headquarters (4,58) and non-management employees (4,54) received higher means.

Table 16. Normative Pressure – univariate statistics

The importance of the demand/pressure from (….groups below….) for adoption of eco-innovation was:	Mean	Std. Dev.	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
From Management employees (Top executives; Top Managers) (NP8)	4,66	0,736	-2,435	0,107	5,983	0,213
From Public authorities (government, state, municipal) (NP1)	4,63	0,791	-2,654	0,107	7,681	0,213
From Corporate headquarters (NP2)	4,58	0,833	-2,164	0,107	4,398	0,213
From Non-management employees (Employees) (NP9)	4,54	0,848	-2,064	0,107	4,015	0,213
From Household consumers/clients (NP3)	4,4	0,938	-1,526	0,107	1,651	0,213
From Commercial buyers (NP4)	4,37	0,977	-1,552	0,107	1,735	0,213
From Suppliers of goods and services (NP5)	4,27	1,007	-1,382	0,107	1,274	0,213
From Neighbourhood/community groups & organisations (NP13)	4,08	1,314	-1,144	0,107	-0,098	0,213
From International partners (NP15)	4,06	1,25	-1,135	0,107	0,068	0,213
From Competitors (NP14)	4,04	1,231	-1,087	0,107	0,006	0,213
From Labour unions (NP10)	4	1,212	-0,987	0,107	-0,108	0,213
From Industry or trade associations (NP11)	4	1,215	-1,004	0,107	-0,069	0,213
From Environmental groups or organisations (NP12)	3,91	1,267	-0,928	0,107	-0,303	0,213
From Shareholders and investment funds (NP6)	3,88	1,196	-0,878	0,107	-0,167	0,213
From Banks and other lenders (NP7)	3,84	1,244	-0,834	0,107	-0,36	0,213
Cronbach's alpha (n=525; 15 items)	*0,950*					

Technology turbulence, in Table 17, that is, how changing technology can boost eco-innovation and environmental performance presented an internal consistency (alpha=0,853) and seems to be quite important. Answers were in average close to strongly agree (5) for all items, indicating that technology in this sector is quite pushing for increasing adoption of eco-innovation.

Table 17. Technology turbulence – univariate statistics

	Mean	Std. Dev.	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
The technology in our industry is changing rapidly. (T1)	4,15	,823	-,740	,107	,077	,213
Technological changes provide big opportunities in our industry. (T2)	4,11	,827	-,613	,107	-,207	,213
It is very difficult to forecast where the technology in our industry will be in the next 2 to 3 years. (T3)	4,23	,880	-1,114	,107	,917	,213
A large number of new product ideas have been made possible through technological breakthroughs in our industry. (T4)	4,18	,759	-,609	,107	-,155	,213
Technological developments in our industry are rather major. (T5)	4,26	,736	-,831	,107	,518	,213
Cronbach's alpha (n=525; 5 items)	*0,853*					

The importance of top managers and of an environmental leadership is strongly supported by literature (see Table 4). For companies investigated in this study, this is also valued and an internal trigger and influential manager can play an important role. Top

executives are very important to guide the strategy, and inspire a shared vision of all environmental initiatives within the company (3,98). Environmental management is also strongly connected to environmental strategy (4,16). Table 18 brings its univariate statistics.

Table 18. Managerial environmental concern – univariate statistics

	Mean	Std. Dev.	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
Most environmental innovations are worthwhile. (EMC7)	4,46	0,694	-1,319	0,107	2,072	0,213
Environmental innovation is an effective environmental management strategy. (EMC8)	4,29	0,731	-0,897	0,107	0,839	0,213
Environmental innovation is an important component of the company's environmental management strategy. (EMC6)	4,16	0,808	-0,7	0,107	-0,102	0,213
Environmental innovation is necessary to achieve high levels of environmental performance. (EMC5)	4,08	0,793	-0,555	0,107	-0,063	0,213
The leaders within the company inspire a shared vision of the organization as environmentally sustainable, creating or maintaining green values throughout the company. (EMC1)	3,98	0,882	-0,573	0,107	-0,306	0,213
The leaders within the company can take on the responsibility of environmental education with the intent of engaging employees in environmental management initiatives. (EMC4)	3,91	0,811	-0,372	0,107	-0,364	0,213
The leaders within the company create partnerships with the company's stakeholders to solve environmental problems and to accomplish environmental goals. (EMC3)	3,8	0,823	-0,448	0,107	-0,095	0,213
The leaders within the company utilize well-developed approaches to environmental management which generally center around a program customized to the company's specific business and market. (EMC2)	3,63	0,947	-0,201	0,107	-0,626	0,213
Cronbach's alpha (n=525; 4 items)	*0,905*					

In relation to the perceived effects that the adoption of eco-innovation (Table 19) had in the performance of the company, measured in a 5-point scale, from substantial negative (1) to substantial positive (5), results show positive trends. The adoption of eco-innovation on performance is positive (4,29), as well as its effects on market share and on economic performance is perceived as quite interesting by respondents in this sample. In general, eco-innovation is related to an enhancement in performance for its improvement in efficiency, by using less polluting materials, in addition to other commercial reasons (image, etc).

Table 19. Performance – univariate statistics

	Mean	Std. Dev.	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
The effect of the adoption of eco-innovation on market share was... (P1)	3,82	,885	-,458	,107	-,213	,213
The effect of the adoption of eco-innovation on sales growth was... (P2)	3,61	,925	-,286	,107	-,243	,213
The effect of the adoption of eco-innovation on return on investment was…. (P3)	3,73	,917	-,237	,107	-,448	,213
The effect of the adoption of eco-innovation on environmental performance was…. (P4)	4,29	,788	-1,169	,107	1,770	,213
The effect of the adoption of eco-innovation on economic performance was…. (P5)	3,82	,917	-,520	,107	-,010	,213
Cronbach's alpha (n=525; 5 items)	*0,912*					

5.1.2.1 Univariate - other constructs, not included in the model.

The following constructs were measured and will be analysed only in terms of univariate statistics. As previously mentioned, potential problems in estimation of structural equation models can occur when observed variables departs substantially from uni and multivariate normality (West, Finch, & Curran, 1995). Although observation of skewness and kurtosis of the univariate distribution are only an initial check on multivariate normality, it is known that distributions that deviate from normality tend to possess significant nonzero skewness and kurtosis, the case of these scales (Table 20). In addition, SEM analysis are based on variance, and some of the items, with very low standard deviations (such those with < 0.80) does not fulfil this criteria and can be a source of problems in the estimation.

Although West, Finch and Curran (1995, p.71) define the existence of several rules of thumb, for example when citing George and Mallery (2010) that recommends kurtosis +- 2 not satisfactory, but they advise that +- 1 for skewness should push for non-normality (West, Finch and Curran, 1995). Kline (2011, p.63) considers variables with extreme skewness, those with an absolute value higher than 3, and kurtosis over 8.

Government Support was the factor with the lowest mean, meaning that companies from this sample do not consider that the government act in a supportive way to influence the adoption of eco-innovation. Collaboration with different stakeholders seems to be an important driver (means around from 4,60 to 4,75). Importance of Human Resources presented high reliability (alpha=0,899), and high means (4,65 – 4,74). This result ratifies that human resources is essential to contribute with more eco-innovations

in food companies, both by training and motivation, as well as by encouragement from top managers, ratifying the results above.

Nevertheless, as it can be seen, results present high kurtosis and skewness statistics. This means that answers tend too much to one extreme (long left tailed for negative skewness or to the right when it is positive). Or it means that probability density is too concentrated, and low variability is founded, case of high kurtosis, with long thin tails, differing from normal curve (West, Finch and Curran (1995).

Table 20. Government support, human resources and collaboration – univariate statistics

Government support	**Mean**	**Std. Dev.**	**Skewness Statistic**	**Std. Error**	**Kurtosis Statistic**	**Std. Error**
Government provides financial support for adopting eco-innovation.	1,48	,892	2,011	,107	3,683	,213
Government provides technical assistance for adopting eco-innovation.	1,35	,828	2,607	,107	6,591	,213
Government helps training manpower with green skills for eco-innovation.	1,30	,782	2,961	,107	8,742	,213
Cronbach's alpha (n=525; 3 items)	*0,927*					
Human resources	**Mean**	**Std. Dev.**	**Skewness Statistic**	**Std. Error**	**Kurtosis Statistic**	**Std. Error**
Importance of personnel commitment to environmental matters for adoption of an eco-innovation.	4,69	,580	-2,231	,107	6,997	,213
Importance of personnel motivation for adoption of an eco-innovation.	4,65	,619	-1,928	,107	4,178	,213
Importance of training for sustainability approach for adoption of an eco-innovation.	4,66	,638	-2,031	,107	4,334	,213
Importance of top management to encourage employees to learn green practices for adoption of an eco-innovation.	4,74	,567	-2,594	,107	8,091	,213
Cronbach's alpha (n=525; 4 items)	*0,899*					
Collaboration	**Mean**	**Std. Dev.**	**Skewness Statistic**	**Std. Error**	**Kurtosis Statistic**	**Std. Error**
Importance of collaboration with government	4,78	0,571	-3,312	0,107	12,947	0,213
Importance of collaboration with professional and industrial associations	4,75	0,535	-2,519	0,107	7,558	0,213
Importance of collaboration with suppliers	4,72	0,606	-2,394	0,107	6,255	0,213
Importance of collaboration within your company	4,71	0,611	-2,518	0,107	7,59	0,213
Importance of collaboration with customers/consumers/clients for developing/adopting an eco-innovation	4,66	0,628	-1,948	0,107	4,073	0,213
Importance of collaboration with competitors or other enterprises of the same industry	4,66	0,659	-2,315	0,107	6,216	0,213
Importance of collaboration with university, research centre or other higher education institutions	4,6	0,653	-1,81	0,107	3,734	0,213
Cronbach's alpha (n=525; 7 items)	*0,884*					

Top management risk aversion was tested to envision how adventurous managers in this sample were. Due to relatively medium to high means, top managers from these companies seemed to relatively tolerate a certain amount of risk to adopt new practices. According to the literature, top managers are willing to take risks and to accept high exposure in the sense of taking sole responsibility (Calantone, Garcia, & Dröge, 2003), as we found in this study. Further investigation in this aspect is suggested.

Table 21. Top management risk aversion – univariate statistics

	Mean	Std. Dev.	Skewness Statistic	Std. Error	Kurtosis Statistic	Std. Error
Top managers in this company believe that higher financial risks are worth taking for higher rewards.	3,85	1,007	-0,578	0,107	-0,309	0,213
Top managers in this company like to act boldly."	3,82	0,948	-0,591	0,107	-0,087	0,213
Top managers in this company decide to implement plans even if they are not certain that they will work.	3,64	1,067	-0,523	0,107	-0,38	0,213
Top managers in this company accept occasional new product failures as being normal.	3,62	1,025	-0,485	0,107	-0,273	0,213
Top managers in this company encourage the development of innovative marketing strategies, knowing well that some will fail.	3,56	1,065	-0,502	0,107	-0,308	0,213
Cronbach's alpha (n=525; 5 items)	*0,873*					

5.1.3 Exploratory Factor Analysis

In order to prepare data for multivariate analysis, an exploratory factor analysis (EFA) was conducted. Exploratory factor analysis (EFA) is classified as one of the traditional methods to assess unidimensionality (Koufteros, 1999) aiming at defining the underlying structure among variables in analysis (Hair *et al.*, 1998). EFA acts both to determine how many constructs are need to explain the complete set of items, and to provide a means of explaining variation among relatively a large number of original items or indicators (Byrne, 2010; Koufteros, 1999).

Although EFA is among traditional methods for scales measurement, it cannot be used as solely technique to assess unidimensionality, but it can be helpful to develop measurement models that will be further tested with confirmatory analytic techniques (Koufteros, 1999). So, considering that some of the variables presented kurtosis and skewness statistics a bit problematic, an exploratory factor analysis were carried out.

The following seven constructs were submitted to EFA: Environmental capability (4 items – EC1 - 4), environmental strategy (ST1 – 4), normative pressure (NP1 – 15), environmental regulations (ER1 – 6), technology (T1 – 5), managerial environmental concern (EMC1 – 8) and environmental performance (P1 – 5). The principal component

analysis with varimax rotation and Keiser-Meyer-Olkin (KMO) test was performed to quantify intercorrelations among the variables and the appropriateness of factor analysis (Hair *et al.*, 1998). KMO result was 0,926, being considered as meritorious indicating that the sample is adequate. Another test run in this phase was the Bartlett test of sphericity, a statistical test for the presence of correlations among variables that provides statistical probability of appropriateness of factor analysis. Bartlett's test scored 19124,800, significance level was 0.000, indicating adequacy and significant correlations. As result from the first EFA, eight factors were found for an eigenvalue higher than 1, as shown in Table 22. The explained variance was 69,08%.

Table 22. Exploratory Factor Analysis

Factors / Constructs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Items	Factor Loadings	Factor Loadings	Factor Loadings	Factor Loadings	Factor Loadings	Factor Loadings	Factor Loadings	Factor Loadings
NP11	,920							
NP12	,911							
NP13	,864							
NP14	,861							
NP15	,831							
NP10	,826							
NP6	,769							
NP7	,764							
NP5	**,585**							**,550**
NP9	**,572**							**,434**
EMC6		,830						
EMC8		,799						
EMC5		,760						
EMC7		,718						
EMC4		,641						
EMC2		,632						
EMC1		,618						
EMC3		,607						
P2			,825					
P3			,812					
P5			,799					
P1			,775					
P4			,669					
ER6				,799				
ER5				,732				
ER4				,698				
ER3				,627				
ER1				,605				
ER2		**,361**		**,528**				

ST3		,785				
ST1		,783				
ST2		,778				
ST4		,773				
T4			,767			
T3			,753			
T5			,735			
T2			,658			
T1			,642			
EC2				,900		
EC3				,876		
EC4				,857		
EC1				,768		
NP2	**,413**					**,726**
NP4	**,517**					**,664**
NP3	**,490**					**,642**
NP8	**,392**					**,499**
NP1	**,350**					**,470**

Source: research data

As can be been in Table 22, most of the constructs were well determined, and items were adequately assigned to its respective factor. However some of the variables underlined more than one factor, leading to the problem that it could be assigned to more than one factor. Since the aim is that items are unidimensional, meaning that they are strongly associated with each other and represent a single concept, a variables with more than one high loading is a candidate for deletion (Hair *et al.*, 1998).

A new EFA was conducted without the following items ER2, NP1 – 5, NP5, NP8 – 9, with significant scores, KMO (Keiser-Meyer-Olkin) was 0,918 and Bartlett's test was significant and scored 15595,922 (Hair Jr. *et al.*, 1998). The following items (Table 23) were also subject to confirmatory factor analysis as next step, presented in section 5.2.2.

Table 23. Exploratory Factor Analysis – Items and constructs to CFA

Constructs	Normative Pressure	Managerial Environmental Concern	Environmental Performance	Environmental Strategy	Technology	Environmental Capability	Environmental Regulations
Items	1	2	3	4	5	6	7
NP11	,915						
NP12	,914						
NP13	,876						
NP14	,869						
NP15	,840						
NP10	,831						

NP6	,788					
NP7	,777					
EMC6		,831				
EMC8		,802				
EMC5		,763				
EMC7		,724				
EMC4		,641				
EMC2		,628				
EMC1		,614				
EMC3		,603				
P2			,831			
P3			,817			
P5			,813			
P1			,774			
P4			,692			
ST3				,803		
ST1				,796		
ST4				,793		
ST2				,788		
T4					,769	
T3					,758	
T5					,744	
T2					,667	
T1					,655	
EC2						,900
EC3						,875
EC4						,859
EC1						,774
ER6						,813
ER5						,740
ER4						,700
ER3						,631
ER1						,566

Next section, multivariate analysis will be described and hypothesis will be tested through structural equation modelling.

5.2 MULTIVARIATE ANALYSIS

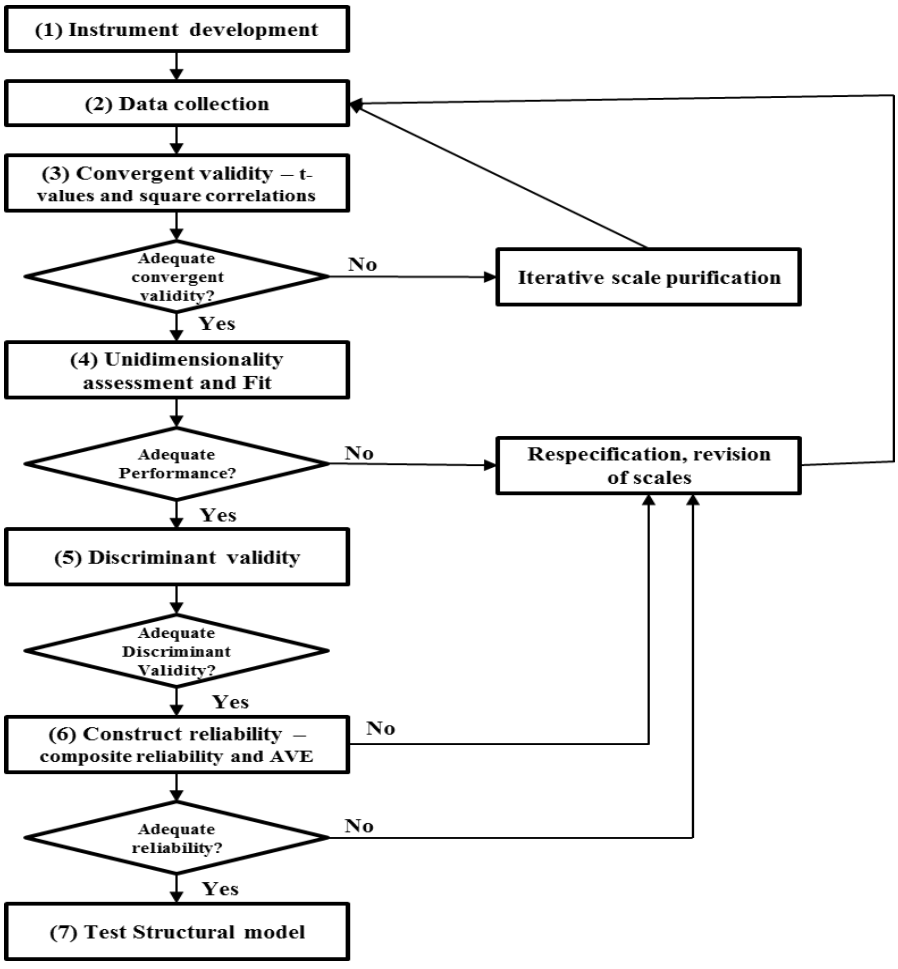
Multivariate analysis followed structural equation modelling procedures, in which estimation methods and details of application were already discussed in the method. Analysis followed covariance matrix analysis, using the software Amos 18.0. Considering assumptions for SEM, as stated in the method, all precautions were taken.

SEM is sensitive to distributional characteristics of the data, particularly when multivariate normality is not accomplished or there is strong kurtosis and skewness (Hair *et al.*, 1998).

Koufteros (1999) recommend the following scheme for structural equation modelling, which was followed in this study. First two steps, instrument development and data collection were detailed in the method chapter and other steps are done in this chapter, starting with exploratory factor analysis. Further, unidimensionality assessment is further examined with CFA, then discriminant validity, construct reliability and structural model.

So, the measurement model defines relations between the observed and unobserved variables, providing the link between scores on a measuring instrument (observed variables) and the underlying constructs (unobserved variables) (Byrne 2010). Structural equation modelling defines, in contrast, relations among constructs (section 5.3).

Figure 9. Assessment for measurement properties – SEM



Source: Koufteros (1999, p. 475)

Goodness of fit statistics, analysed in step 4, include analysis of several indices to assess the degree the actual or observed input matrix (covariances or correlations) is predicted by the estimation model (Hair *et al.*, 1998). Although the relevance of $\chi 2$ (chi-square) statistic to test the model accuracy to reproduce the sample variance/covariance matrix, this value can be very sensitive to sample size and multivariate normality, requiring other additional measures as follows (Koufteros, 1999).

The ratio of $\chi 2$ to degrees of freedom (CMIN/DF) – minimum discrepancy - CMIN/degree of freedom - DF is one of main statistics for SEM. A large value in this statistics means that the observed and estimated model differs a lot, it is indicated that values under 3 represent a good fit of the estimated model.

The Bentler and Bonnet normed fit index (NFI) is one of the more popular measure and is a relative comparison of the proposed model to null model, being recommended values equal or greater than 0,90.

The Bentler and Bonnet non-normed fit index (NNFI), also called Tucker-Lewis index - TLI or non-normed fit index - NNFI (Hair *et al.*, 1998; Koufteros, 1999) combines a measure of parsimony into a comparative index between the proposed and null models, being recommended values equal or greater than 0,90.

The Bentler comparative fit index (CFI) also compares proposed and null model, and values greater than 0,90 represent models with adequate fit.

The Root Mean Square Error of Approximation (RMSEA) is another measure that aim to correct sample size sensitiveness of the chi-square $\chi 2$, representing the discrepancy per degree of freedom. Values under 0,8 are acceptable.

Goodness of Fit index (GFI) represents the overall degree of fit (the squared residuals from prediction compared with the actual data), but it is not adjusted per degree of freedom. Values range from 0 (poor fit) to 1,0 (perfect fit).

Adjusted Goodness of Fit index (AGFI) is an extension of the GFI, adjusted by degrees of freedom, recommended accepted values equal or greater than 0,90.

Parsimonious Normed Fit Index (PNFI) takes degree of freedom into account and parsimony is defining as achieving higher degree of fit per degree of freedom. Higher values are better, and it is mainly use to compare models with different degrees of freedom. It is recommended values next to 1,0.

Parsimony comparative fit index (PCFI) is the adjusted CFI per number of estimated parameters, values next to 1,0 are expected.

5.2.1 Measuring of sample adequacy

Therefore, final model remained with 7 constructs and 39 items in total before measurement model and confirmatory analysis, when it remained with the same 7 constructs, and 31 items. Considering this and the most appropriate sample size recommended by Hair *et al.* (1998) that is 10 respondents per parameter the final sample of 525 is perfectly fitted. Going on with tests to sampling adequacy, as previously shown, Keiser-Meyer-Olkin (KMO) test was considered as meritorious indicating that the sample is adequate (Hair *et al.*, 1998). As well as Bartlett test of sphericity, indicating adequacy and significant correlations for this sample.

5.2.2 Confirmatory factorial analysis for each individual construct

Before undertaking analysis for all items in the measurement model, each construct was evaluated to confirm if all variables were really defining the given construct, although it is not possible to tell how items of one block relate to constructs or items of other blocks (Koufteros, 1999). This procedure allowed the refinement of the model, as well the assessment of composite reliability and average variance extracted (AVE). In addition to examine if the factor loadings to each indicator is adequate, a principal measure used in assessing the measurement model is composite reliability for each construct (Hair *et al.*, 1998, p. 612). Composite reliability means that a set of latent construct indicators are consistent in their measurement (Koufteros, 1999). That is, reliability is a measure of internal consistency, in which is evaluate the degree to which constructs are measuring what they are supposed to measure (Hair *et al.*, 1998). Ideally, composite reliability must be over 0,7.

Another measure for reliability is average variance extracted (AVE), that reflects the overall amount of variance in the indicators accounted for by the latent construct, that is, higher AVE (should be higher than 0,5) means that the indicators are truly representative of the latent construct (Hair *et al.*, 1998, p. 612). Composite reliability and AVE are complementary, and together with cronbach's alpha will be measured in this section for each construct.

First, environmental capability could kept four items, and unidimensionality and convergent validity. Both composite reliability and AVE were satisfactory, 0,90 and 0,69

respectively. T-values were significant, and no standard error is bigger than |2,58|. Standard errors are analogous to z-score and they represent estimates of number of standard deviations the observed residuals are from zero residuals (perfect fit model), values cannot be greater than |2,58| at ,001 level or |1,96| at 0,05 level (Byrne, 2010). The construct environmental strategy also kept four items, and presented a significant internal consistency, as can be been in Table 24.

The construct environmental regulations, needed to be purified, since first assessment was unsatisfactory, AVE < 0,5, and standardized loadings very weak for items ER1 and ER3, that were removed from the final model. Purified construct remained with three items and achieved all reliability indexed, as can be seen in Table 24, environmental regulations adjusted.

Normative pressure was another construct that kept all items measured in this phase, as can be seen in Table 24. Strong reliability was found, meaning that the construct is actually measuring what it was supposed to measure. As well as technology, that kept 5 items, and managerial environmental concern, with satisfactory reliability indexes. Environmental performance, although presented good reliability, had one item removed. The item P4 had a very weak connection with the construct, mainly due to cross loadings, since this item attached to other construct in the same measurement model. In addition, purified version of the construct presented better reliability scores.

Table 24. CFA – individual constructs and reliability

Construct	Relationship variable – construct	Unstandardized factor loading	Standardized Estimate (Factor Loading)	C.R. (t-values)*	Error (Variance)
Environmental Capability	EC1 <--- Env. Capability	1	0,761	- **	
	EC2 <--- Env. Capability	1,206	0,909	21,515	0,056
	EC3 <--- Env. Capability	1,153	0,835	19,838	0,058
	EC4 <--- Env. Capability	1,116	0,817	19,354	0,058
Composite Reliability = 0,90; AVE = 0,69; Cronbach's alpha = 0,898					
Environmental Strategy	ST1 <--- Env. Strategy	1	0,868	-**	
	ST2 <--- Env. Strategy	0,951	0,874	26,754	0,036
	ST3 <--- Env. Strategy	0,926	0,863	26,146	0,035
	ST4 <--- Env. Strategy	0,976	0,886	27,381	0,036
Composite Reliability = 0,93; AVE = 0,76; Cronbach's alpha = 0,927					
Environmental Regulations	ER1 <--- Env. Regulation	1	0,559***	-**	
	ER3 <--- Env. Regulation	0,872	0,541***	9,681	0,09
	ER4 <--- Env. Regulation	1,121	0,707	11,526	0,097
	ER5 <--- Env. Regulation	1,311	0,75	11,902	0,11
	ER6 <--- Env. Regulation	1,237	0,842	12,439	0,099
Composite Reliability = 0,81; **AVE = 0,48**; **Cronbach's alpha = 0,808**					

Environmental Regulations – Adjusted	ER1 <--- Env. Regulation	1	0,667	_**	1
	ER2 <--- Env. Regulation	1,254	0,76	14,196	1,254
	ER3 <--- Env. Regulation	1,211	0,872	13,924	1,211
Composite Reliability = 0,81; **AVE = 0,59**; **Cronbach's alpha = 0,804**					
Normative Pressure	NP6 <--- Normative Pressure	1	0,724	-**	
	NP7 <--- Normative Pressure	1,02	0,71	16,303	0,063
	NP10 <---Normative Pressure	1,118	0,799	18,463	0,061
	NP11 <---Normative Pressure	1,285	0,916	21,348	0,06
	NP12 <---Normative Pressure	1,361	0,93	21,701	0,063
	NP13 <---Normative Pressure	1,371	0,904	21,042	0,065
	NP14 <---Normative Pressure	1,27	0,894	20,794	0,061
	NP15 <---Normative Pressure	1,228	0,85	19,726	0,062
Composite Reliability = 0,95; **AVE = 0,71**; **Cronbach's alpha = 0,952**					
Technology	T1 <--- Technology	1	0,618	-**	
	T2 <--- Technology	1,109	0,682	12,722	0,087
	T3 <--- Technology	1,189	0,688	12,798	0,093
	T4 <--- Technology	1,268	0,851	14,712	0,086
	T5 <--- Technology	1,206	0,834	14,568	0,083
Composite Reliability = 0,86; AVE = 0,55; Cronbach's alpha = 0,853					
Environmental Managerial Concern	EMC1<--Env.Man.Concern	1	0,654	-**	
	EMC2<--Env.Man.Concern	1,155	0,703	14,158	0,082
	EMC3<--Env.Man.Concern	0,947	0,664	13,474	0,07
	EMC4<--Env.Man.Concern	0,988	0,703	14,147	0,07
	EMC5<--Env.Man.Concern	1,103	0,802	15,755	0,07
	EMC6<--Env.Man.Concern	1,185	0,846	16,423	0,072
	EMC7<--Env.Man.Concern	0,877	0,729	14,584	0,06
	EMC8<--Env.Man.Concern	1,039	0,82	16,029	0,065
Composite Reliability = 0,91; AVE = 0,55; Cronbach's alpha = 0,90					
Environmental Performance	P1 <--- Performance	1	0,798		1
	P2 <--- Performance	1,138	0,869	22,742	1,138
	P3 <--- Performance	1,132	0,872	22,837	1,132
	P4 <--- Performance	0,767	0,688	16,793***	0,767
	P5 <--- Performance	1,138	0,876	22,993	1,138
Composite Reliability = 0,91; AVE = 0,68; Cronbach's alpha = 0,912					
Environmental Performance - Adjusted	P1 <--- Performance	1	0,787		
	P2 <--- Performance	1,167	0,879	22,411	0,052
	P3 <--- Performance	1,147	0,872	22,189	0,052
	P5 <--- Performance	1,15	0,874	22,256	0,052
Composite Reliability = 0,93; AVE = 0,72; Cronbach's alpha = 0,914					

*p<0,001
**Indicates a parameter fixed at 1, t-values are not calculated
***items removed from final model

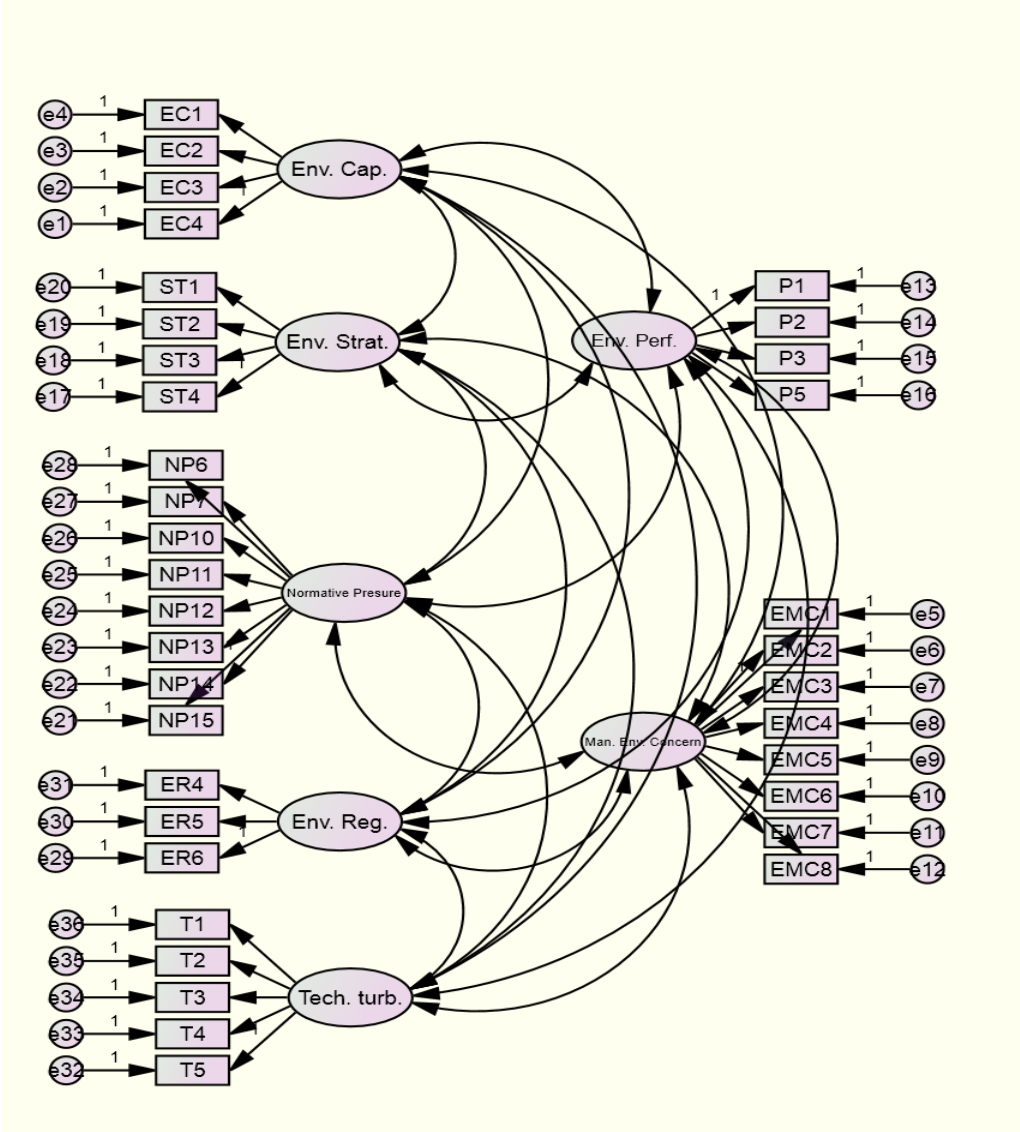
5.2.3 Confirmatory Factor Analysis – Measurement model

Confirmatory factor analysis (CFA) is one of the components of structural equation modelling that specifies the indicators for each construct and assesses the reliability for each construct to estimate causal relationships (Hair *et al.*, 1998). CFA involves the specification and estimation of models, each of which proposes a set of latent variables (factors) to account for covariances among a set of observed variables

(Koufteros, 1999, p. 474). The measurement model specifies how hypothetical constructs (latent) are measured in terms of the observed variables for later, the structural model specifies the causal relationships among the latent variables (Koufteros, 1999).

The measurement model, third step according to Koufteros (1999) is performed with the entire set of items, as recommended. The path diagram (Figure 10) presents seven constructs and corresponding indicators. In this model, according AMOS path diagrams, circles (or ellipses) represent unobserved latent factors, in this case, constructs or measurement errors; squares (or rectangles) represent observed variables, that is, items in the questionnaire, and single headed arrows represent the impact of one variable in the other, while double headed arrows represent covariances or correlations between pair of variables (Byrne, 2010).

Figure 10. Measurement model – first version



Having the first version of measurement model, next step requires analysis of convergent validity, that is, analyse t-values and standardized factor loadings. In CFA, on the first order level of measurement models, the standard factor loadings of observed variables (items) on latent variables (constructs) are estimates of the validity of the observed variables (Koufteros, 1999, p. 477). Convergent validity can be assessed through t-values (ratio of factor loadings to their respective standard errors), if these values are greater than |2| or |2,576| then they are considered significant at 0,05 and 0,01 level, respectively (Koufteros, 1999, p. 477).

Table 25. Measurement model – CFA first version

Construct	Items	Unstandardized factor loading	Standardized Estimate (Factor Loading)	C.R. (t-values)*	Standard Errors
Environmental capability	EC1	1,108	0,769	-**	-**
	EC2	1,136	0,831	21,853	0,054
	EC3	1,188	0,905	19,573	0,058
	EC4	1	0,769	19,715	0,056
Environmental strategy	ST1	1	0,869	-**	-**
	ST2	0,953	0,876	27,263	0,035
	ST3	0,923	0,861	26,055	0,035
	ST4	0,975	0,886	27,564	0,035
Environmental Regulations	ER4	1	0,711	-**	-**
	ER5	1,194	0,771	14,637	0,082
	ER6	1,075	0,825	15,383	0,07
Normative Pressures	NP6	0,981	0,724	16,498	0,059
	NP7	1	0,71	-** / -***	-**
	NP10	1,096	0,798	17,983***	0,061
	NP11	1,259	0,915	20,619	0,061
	NP12	1,334	0,929	20,889	0,064
	NP13	1,346	0,905	20,264	0,066
	NP14	1,247	0,894	20,01	0,062
	NP15	1,206	0,851	19,032***	0,063
Technology	T1	1	0,628	-**	-**
	T2	1,116	0,697	13,364	0,084
	T3	1,15	0,676	12,959	0,089
	T4	1,235	0,841	14,754	0,084
	T5	1,191	0,837	14,778	0,081
Environmental Managerial Concern	EMC1	0,862	0,669	15,07	0,057
	EMC2	1	0,723	-**	-**
	EMC3	0,821	0,683	15,359	0,053
	EMC4	0,852	0,719	16,115	0,053
	EMC5	0,92	0,795	17,503	0,053
	EMC6	0,975	0,827	18,142	0,054
	EMC7	0,73	0,721	15,714***	0,046
	EMC8	0,861	0,807	17,582***	0,049
Environmental Performance	P1	1	0,793	-**	-**
	P2	1,15	0,873	22,764	0,051
	P3	1,139	0,872	22,447	0,051
	P5	1,143	0,875	22,503	0,051

*p<0,001
**Indicates a parameter fixed at 1, t-values are not calculated
***items removed from final model

Fourth step, according to Koufteros (1999), include the analysis of fit indices for unidimensionality, overall model fit (goodness of fit indexes – Table 26), modification indices and standardized residual covariances. As it can be seen in Table 26, fit indexes are close, but not between the ideal range, indicating that the model needs some adjustments.

Table 26. Fit indices - First version measurement model

Indicators	Recommended Values	Fit indices from the first version of measurement model
X2/df	≤ 3,00	3,453
RMSEA	≤ 0,08	0,068
GFI	≥ 0,90	0,821
CFI	≥ 0,90	0,903
NFI	≥ 0,90	0,869
TLI	≥ 0,90	0,893
AGFI	≅ 1,00	0,792
PNFI	≅ 1,00	0,79
PCFI	≅ 1,00	0,821

Modification indices tell the presence of cross-loading among variables, that is, high values in this index may represent that variables share a significant amount of variance. Taken together modification indices and standard residuals (that cannot be greater than $\left|2.58\right|$, decisions on removing variables from the model can be made if there is theoretical support (Koufteros, 1999). Analysing these indexes, it was found redundancy in five variables that were removed from the model (NP7, NP10, NP15, EMC7 and EMC8). Modification indices for these five variables ranged from 54,99 to 194,44, way to far from recommended values over 15 for Koufteros (1999) and 30 to Byrne (2010).

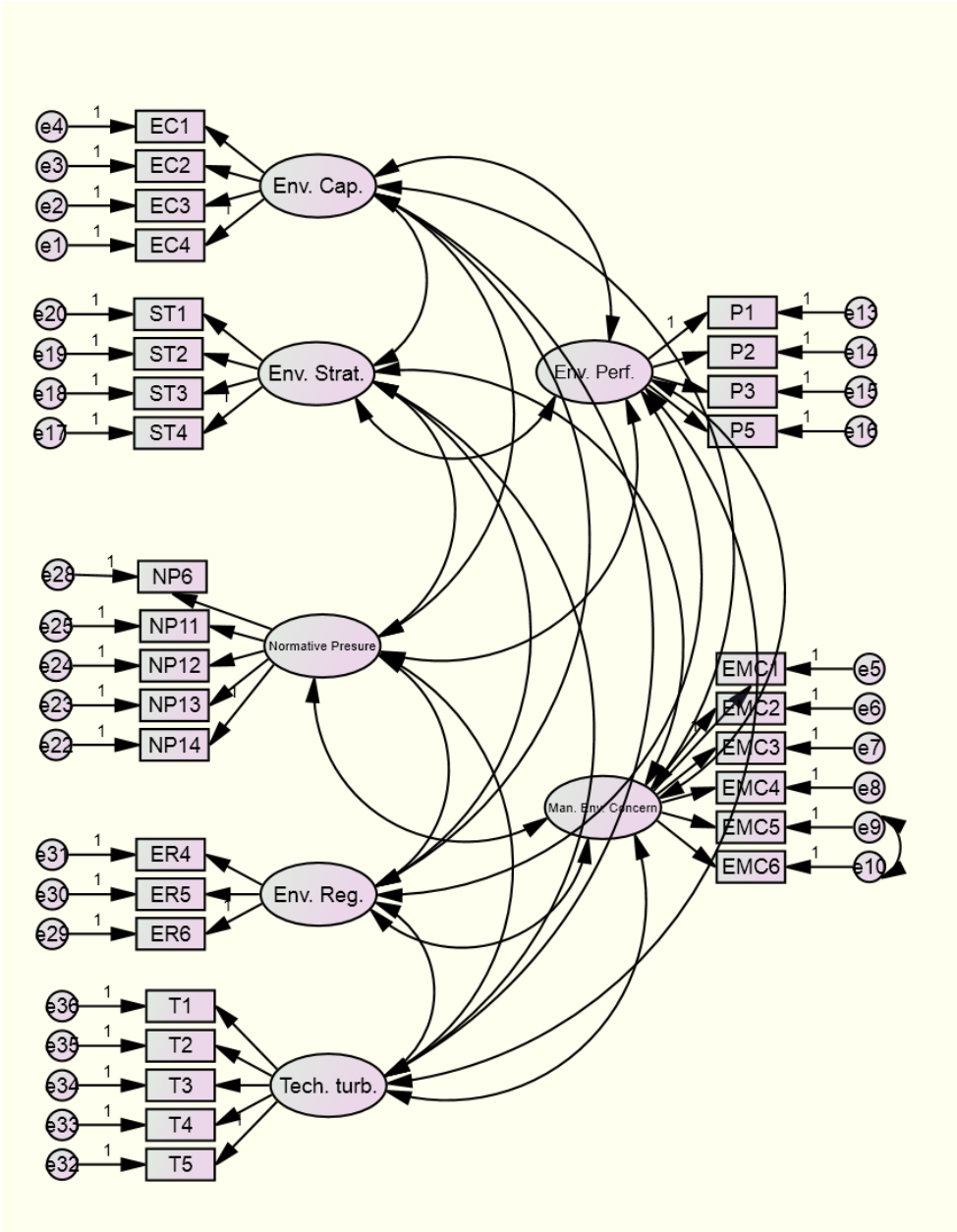
Therefore, from the construct normative pressure, items related to pressures and demands from Banks or other lenders (NP7), from Labour Unions (NP10) and International partners (NP15) were removed from the model. Apparently, more distant stakeholders were eliminated, since its influences were confounded with Shareholders and investment funds demand (NP6), from industry and trade associations (NP11) and from competitors (NP14), respectively.

From the construct Managerial Environmental concern, statements such as environmental innovation are worthwhile (EMC7) and environmental innovation is an

effective environmental strategy (EMC8) were redundant with environmental innovation is an important component of the company's environmental management strategy (EMC6). The two first variables were therefore removed from the final measurement model, as can be seen in Figure 11.

In the final version of the revised measurement model 7 constructs remained, with 31 variables, as can be seen in Figure 11.

Figure 11. Revised measurement model



Next step, fifth stage preconized by Koufteros (1999) is the assessment of discriminant validity. Fornell and Larcker (1981) suggest that discriminant validity exists if the items share more common variance with their respective construct than any variance

that construct shares with other constructs. To test discriminant validity, AVE of each construct must be compared with the squared correlation between constructs, and the AVE for a construct should be substantially higher than the squared correlation between that construct and all other constructs (Koufteros, 1999). Table 27 shows that AVE (bold numbers in the diagonal) are superior than squared correlations, indicating that this revised measurement models provided evidence of supporting discriminant validity.

Table 27. Discriminant validity

	Env. Capab	Env. Strategy	Env. Regulation	Normative Pressure	Technology	Performance	Env. Man. Concern
Env. Capab	**0,69**						
Env. Strategy	0,05	**0,76**					
Env. Regulation	0,01	0,25	**0,59**				
Normative Pressure	0,03	0,00	0,01	**0,76**			
Technology	0,04	0,24	0,21	0,12	**0,75**		
Performance	0,05	0,35	0,20	0,00	0,19	**0,72**	
Env. Man. Concern	0,10	0,43	0,29	0,04	0,31	0,34	**0,56**

Next step, sixth in Koufteros (1999), is related to the assessment of construct reliability, measured by composite reliability and AVE. As can be observed in Table 28, all t-values presented values higher than 2,576, AVE higher than 0,50 and composite reliability higher than 0,70, what indicates good reliability of the revised measurement model.

Table 28. Fit indices Revised Measurement model

Construct	Items	Unstandardized factor loading	Standardized Estimate (Factor Loading)	C.R. (t-values)*	Standard Errors
Environmental capability	EC1	0,902	0,769	19,745	0,046
	EC2	1,071	0,905	23,556	0,045
Composite Reliability = 0,90	EC3	1,024	0,831	21,941	0,047
AVE = 0,69	EC4	1	0,82	-**	-**
Environmental strategy	ST1	1,027	0,87	27,608	0,037
	ST2	0,977	0,876	27,858	0,035
Composite Reliability = 0,93	ST3	0,946	0,86	27,34	0,035
AVE = 0,76	ST4	1	0,885	-**	-**
Environmental Regulations	ER4	0,928	0,709	15,355	0,06
Composite Reliability = 0,81	ER5	1,114	0,773	17,442	0,064
AVE = 0,59	ER6	1	0,825	-**	-**
Normative Pressures	NP6	0,769	0,699	19,285	0,04
	NP11	0,993	0,889	30,008	0,033
Composite Reliability = 0,94	NP12	1,105	0,948	34,582	0,032
AVE = 0,76	NP13	1,118	0,926	33,183	0,034
	NP14	1	0,883	-**	-**
Technology	T1	0,842	0,628	14,768	0,057
Composite Reliability = 0,86	T2	0,94	0,698	16,956	0,055
AVE = 0,55	T3	0,969	0,676	16,172	0,06
	T4	1,04	0,842	22,262	0,047
	T5	1	0,835	-**	-**

Environmental Managerial Concern	EMC1	1	0,712	-**	-**
	EMC2	1,189	0,788	16,845	0,071
Composite Reliability = 0,88	EMC3	0,969	0,739	15,626	0,062
AVE = 0,56	EMC4	0,974	0,754	15,824	0,062
	EMC5	0,889	0,704	14,889	0,06
	EMC6	0,915	0,711	15,058	0,061
Environmental Performance	P1	1	0,793	-**	-**
	P2	1,15	0,872	22,762	0,051
Composite Reliability = 0,93	P3	1,14	0,873	22,459	0,051
AVE = 0,72	P5	1,143	0,875	22,505	0,051

*p<0,001
**Indicates a parameter fixed at 1, t-values are not calculated

Based on the revised measurement model, new fit indexes were calculated. As can be seen in Table 29, all fit indexes improved, satisfying recommended values. Modifications in the model have increased reliability and allowed the researcher to move forward to the next step, the analysis of the structural model.

Table 29. Fit indices for the revised measurement model

Indicators	Recommended Values	Fit indices from the first version of measurement model	Fit indices from the revised version of measurement model
X2/df	≤ 3,00	3,453	2,106
RMSEA	≤ 0,08	0,068	0,046
GFI	≥ 0,90	0,821	0,903
CFI	≥ 0,90	0,903	0,96
NFI	≥ 0,90	0,869	0,927
TLI	≥ 0,90	0,893	0,955
AGFI	≅ 1,00	0,792	0,883
PNFI	≅ 1,00	0,79	0,821
PCFI	≅ 1,00	0,821	0,851

5.3 STRUCTURAL MODEL

Once an acceptable measurement model is specified, structural model assessment may begin (Koufteros, 1999). Previous section was to prove reliability and validity of the proposed model, necessary steps prior to model test, to examine the estimated coefficients themselves for both practical and theoretical applications (Hair *et al.*, 1998). The structural model can be shown in the path diagram in Figure 12.

The model presents two endogenous constructs (dependent variable), being one of them (environmental managerial concern) also acting as exogenous, and five exogenous constructs, independent predictor constructs. Table 30 present structural paths

and its factor covariances, indicating which are the significant paths to prove or not, based on what was previously predicted in theoretical terms.

Table 30. Structural relations among constructs

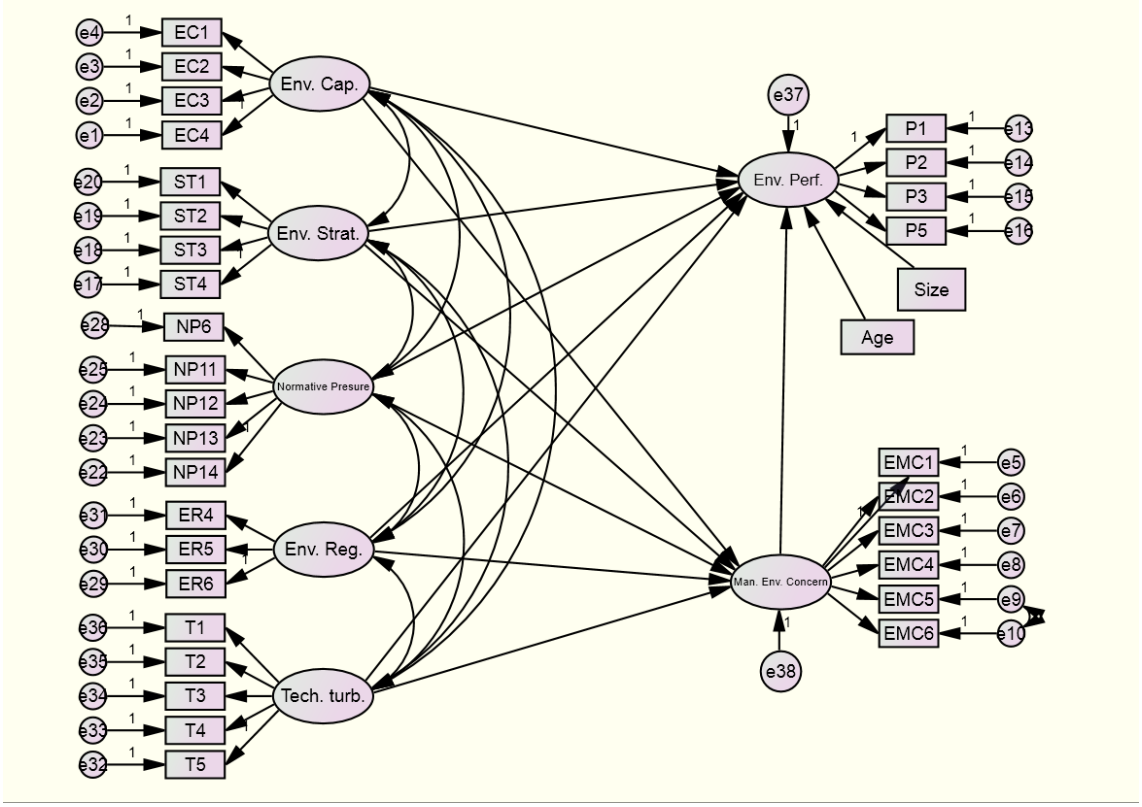
Structural relationship			Unstandardized factor loading	Standardized Estimate (Factor Loading)	S.E.	C.R. (t-values)	P-value
Man. Env. Concern	<---	Env. Cap.	0,108	0,165	0,025	4,236	***
Man. Env. Concern	<---	Env. Strat.	0,331	0,411	0,042	7,969	***
Man. Env. Concern	<---	Normative Presure	0,036	0,062	0,023	1,571	0,116
Man. Env. Concern	<---	Env. Reg.	0,207	0,22	0,047	4,396	***
Man. Env. Concern	<---	Tech. turb.	0,21	0,206	0,053	3,988	***
Env. Perf.	<---	Env. Cap.	0,029	0,04	0,03	0,962	0,336
Env. Perf.	<---	Env. Strat.	0,287	0,32	0,052	5,511	***
Env. Perf.	<---	Normative Presure	-0,02	-0,031	0,027	-0,743	0,458
Env. Perf.	<---	Env. Reg.	0,121	0,116	0,056	2,165	0,03
Env. Perf.	<---	Tech. turb.	0,104	0,091	0,062	1,666	0,096
Env. Perf.	<---	Man. Env. Concern	0,264	0,238	0,075	3,533	***
Env. Perf.	<---	Age	0,002	0,078	0,001	2,144	0,032
Env. Perf.	<---	Size	0	0,083	0	2,241	0,025

***p<0,001

Given relationships tested and presented in Table 30, six were significant at 0,001 level, while three were not significant at all (managerial environmental concern and normative pressure, environmental performance and environmental capability and environmental performance and normative pressure). The relationship environmental performance and environmental regulation were significant at 0,5, with a t-value higher than 1,96, accepted for this significance level (Byrne, 2010). Environmental performance and environmental regulation are significant at 0,1 level, although t-value is a little bit low, what can bring doubts on deciding about the relevance of this relationship.

Two control variables were used in this study: firm size, represented by companies' number of employees, and age, represented by the number of years since the firm was established. Statistical analyses showed both variables have significant effect on environmental performance ($p<0,05$), although with a small magnitude. Effect of size ($\beta = 0,083$), and of age ($\beta = 0,078$) indicate that larger and older companies tend to have better environmental performance.

Figure 12. Structural Model



If the model fits adequately the data, hypotheses can be tested. To assess the model fit, adjustment indices, that is, goodness of fit statistics were measured and are presented in Table 31.

Table 31. Fit indices for the structural model

Indicators	Recommended Values	Fit indices from the structural
X2/df	≤ 3,00	2,076
RMSEA	≤ 0,08	0,045
GFI	≥ 0,90	0,897
CFI	≥ 0,90	0,956
NFI	≥ 0,90	0,918
TLI	≥ 0,90	0,951
AGFI	≅ 1,00	0,877
PNFI	≅ 1,00	0,823
PCFI	≅ 1,00	0,856

As can be noticed, indices are within acceptable borders, meaning that the structural model fits the sample data. Therefore, next section will present the analysis of hypotheses test.

5.4 VERIFYING AND ANALYSIS OF HYPOTHESES

In Table 32, the test of hypotheses is presented.

Table 32. Hypotheses testing

	Hypotheses	standardized factor loading	Level of significance	Decision
1a	Environmental capability affects positively on environmental managerial concern	0,165	0,001	Accepted
1b	Environmental capability affects positively on environmental performance	0,044	0,288	Not confirmed
2a	Environmental innovation strategy affects positively on environmental managerial concern	0,411	0,001	Accepted
2b	Environmental innovation strategy affects positively on environmental performance	0,32	0,001	Accepted
3a	Normative pressure affects positively on environmental managerial concern	0,062	0,116	Not confirmed
3b	Normative pressure affects positively on environmental performance	-0,023	0,391	Not confirmed
4a	Environmental regulation affects positively on environmental managerial concern	0,22	0,001	Accepted
4b	Environmental regulation affects positively on environmental performance	0,116	0,029	Accepted
5a	Technology affects positively on environmental managerial concern	0,206	0,001	Accepted
5b	Technology affects positively on environmental performance	0,091	0,096	-
6	Environmental managerial concern affects positively on environmental performance	0,238	0,001	Accepted
7a	An environmental managerial concern mediates the relationship between Environmental capability and companies' environmental performance.	0,039**	0,032***	Full mediation
7b	An environmental managerial concern mediates the relationship between Environmental innovation strategy and companies' environmental performance.	0,098**	0,018***	Partial mediation
7c	An environmental managerial concern mediates the relationship between Normative pressure and companies' environmental performance.	0,015**	0,088***	No mediation
7d	An environmental managerial concern mediates the relationship between Environmental regulation and companies' environmental performance.	0,052**	0,013***	Partial mediation
7e	An environmental managerial concern mediates the relationship between Technology and companies' environmental performance.	0,049**	0,004***	Full mediation

** Standardized Indirect Effects

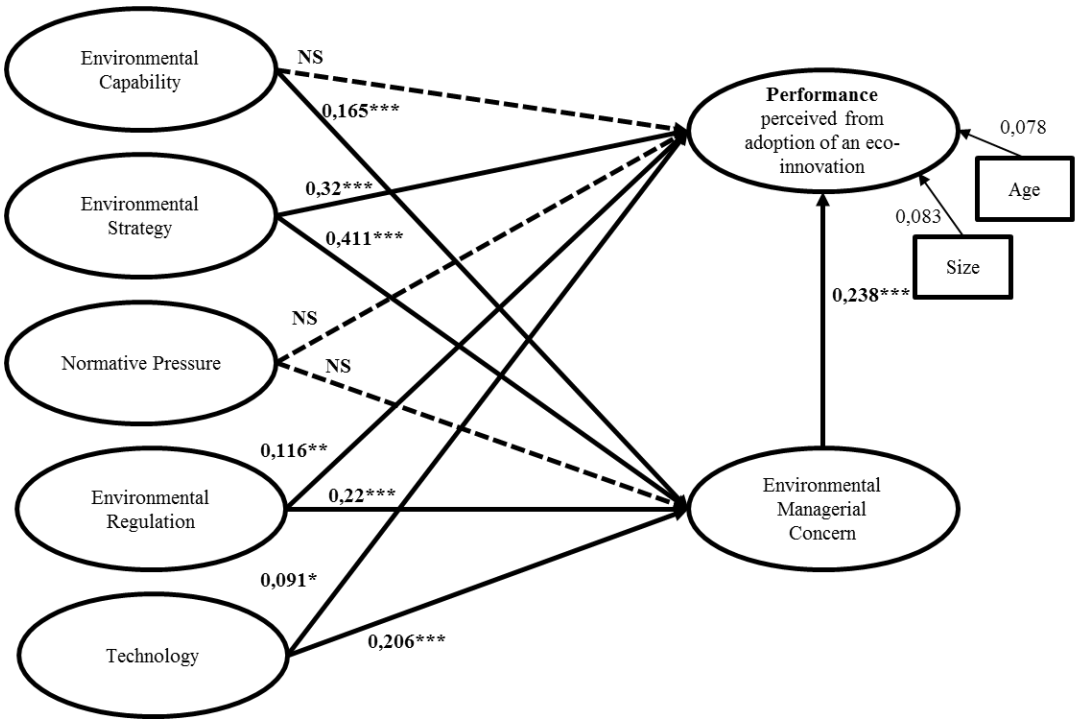
*** two-tailed significance levels for indirect effect

In relation to the influence of environmental capability on environmental managerial concern and on environmental performance, tested through hypothesis H1a and H1b, respectively, it was only found support on the data for hypothesis H1a. Firm's abilities to integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations (Chen, Chang,

& Wu, 2012) play an important role affecting environmental managerial concern (β=0,165), but has no direct effect on environmental performance (H1b – not supported).

This result reinforces literature on the importance of green capabilities to influence environmental managerial concern (Dangelico, 2015), that is, companies with better environmental capabilities will have a positive influence on the awareness of an environmental leadership and on the importance of environmental innovation. This result is also consonant with Schumpeterian innovation literature which believes that innovation is originated inside the company. According to different capabilities, companies will react differently, and this ratifies the importance of having robust environmental capabilities to increase the adoption of eco-innovation. Figure 13 illustrate the final model:

Figure 13. Final model



Solid lines are significant paths, dotted lines are nonsignificant paths
***p<0,001
**p<0,05
*p<0,1

Environmental strategy has the most important and positive effect both on environmental managerial concern (H2a – supported, β=0,411) and on environmental performance (H2b – supported, β=0,32). It has been demonstrated that companies that integrate environmental sustainability in the strategy are more willing to improve environmental performance and environmental managerial concern. Environmental innovation will have more chances to succeed when companies already adopt a sustainable strategy. Such results are aligned with the literature, since companies that strategically adopt an environmental leader position (Gauthier & Wooldridge, 2012), incorporating environmental actions and values throughout the company through its mission and vision (Chang, 2011), will have better chances to implement successful eco-innovations.

This result also ratifies what was found in the exploratory interviews, in which respondents from the food sector that adopted eco-innovation had sustainability values incorporated into their strategy, as a core value. To boost adoption of eco-innovation with positive effects on companies' performance, it is crucial to adopt this strategy as a long-term commitment (Arnold & Hockerts, 2011).

Normative pressure, that is, influence and demand from market forces and other agents, such as local community, environmental groups, shareholders, and competitors have not much significant effect on adoption of eco-innovation, either through the influence on environmental managerial concern (H3a – not supported) or on environmental performance. This result find some support in the literature (Eiadat *et al.*, 2008; Qi *et al.*, 2010), but contradicts most of studies that believe that environmental pressure is likely to increase adoption of eco-innovation (Huang *et al.*, 2009; De Marchi, 2012), by increasing legitimacy (Berrone *et al.*, 2013) or even by aggregating these pressure groups as partners for corroborating with knowledge, skills and resources for increasing adoption of eco-innovation (De Marchi, 2012).

This result is consonant with exploratory research made with consumers[1] in Bossle *et al.* (2015a). Consumers' perception is an important driver to determine how agents from the food chain can persevere in the market. Trends about how consumers

[1] The initial propose of this study was to make a multi-perspective study, analysing consumers' and companies' adoption of eco-innovation. Nevertheless, after the proposal defence, the advisory board suggested to leave the analysis of consumers for additional publications and keep only the study with companies in this dissertation. Papers published as a result of these studies with consumers are attached in the appendix.

value food products are an important contribution to develop the strategy of food companies (Grunert, Brunsø and Bisp, 1993). Nevertheless, in this research with Brazilian consumers, consumers stated that they are aware of their dependence on companies for supplying of green products. But there are massive complains that most decisions taken by companies do not consider neither the environment, nor consumer wishes (Bossle *et al.*, 2015a). That is, companies act according to their internal believes and consumers and society must accept.

Although economic change begins in the supply-side (Schumpeter, 2008), consumers' demand is a relevant driver for changes in products and processes. It is a cycle, where in order to compete and grow, an innovative company must act in a technological, technical, policy, and management environment that allows an innovative approach, whereas market conditions must also be ensured (Bossle *et al.*, 2015a).

The relationship among environmental regulation with environmental managerial concern and environmental performance is positive and significant. Environmental regulations positively affects both environmental managerial concern (β=0,22) and environmental performance (β=0,116). This result brings very interesting analysis, given the Brazilian business scenario, in which entrepreneurs tend to justify some action (or lack of) and complain a lot about the need of complying with regulations. At the same time, exploratory research brought results that could at the same time contradict or support this idea. This is because entrepreneurs alleged that environmental regulations are incomplete and ineffective in Brazil, only encompassing some products (e.g., for organics, main focus in fruits and vegetables). But behind these complaints, there is a belief that environmental regulation could benefit companies that undertake sustainable actions, bringing more awareness for consumers. That is, companies would be therefore able to better communicate about their actions towards eco-innovation (Bossle *et al.*, 2015a).

Environmental regulations can be seen, therefore, as an opportunity rather than just a barrier for companies increasing adoption of eco-innovation (Kesidou & Demirel, 2012). To comply with environmental regulations, companies can bring creative solutions and stimulate the integration between sustainability and innovation (Kesidou & Demirel, 2012). Environmental regulations, although can be considered an external force, has big influences on internal aspects of the company. The government put pressure on companies to behave in a more environmental manner, and companies, even if feel a

budget pressure due to raising costs, later will increase investments in innovation, adding value to its products and for the company as a whole (Bergquist & Söderholm, 2011).

Technology turbulence, that is, external conditions such as a fasting change technology has a quite strong and positive effect on environmental managerial concern (H5a – supported, β=0,206) and an effect, almost significant (p<0,10) on environmental performance (β=0,091). The belief that the technology in the industry is changing rapidly increases companies' awareness on the importance of eco-innovations. That is, since eco-innovation must deal with uncertainties in the market, the level of technology is an important driver to raise awareness in environmental management and increased concern on adoption of eco-innovation.

This result also confirms what was found in the exploratory research with food companies. Entrepreneurs consider technology as an essential input for the supply side, and as an important driver to increase the supply of sustainable food, to reduce losses, and, to improve environmental sustainability. It can also be used to improve packages, which must be ecological, but also practical, modern, and attractive (Bossle *et al.*, 2015a).

This reveals technology as an important factor to boost eco-innovation in the industry, as well as to increase the adoption of more sustainable processes in food industry, given that technology and quality in the process has a direct relationship in the food industry (Bossle *et al.*, 2015a). Although the direct effect of technology on environmental performance is weak, technology in the food industry is seen and an important tool that companies with environmental capabilities can use to differentiate and to add value for the product (Bossle *et al.*, 2015a).

The importance of managerial environmental concern to increase companies' environmental performance due to the adoption of eco-innovation has been tested and hypothesis H6 was supported (β=0,238). It was found support for the assumption that an environmental leadership within the company play an essential role to raise awareness in the company and in influencing others to contribute to the achievement of environmental management and eco-innovations (Chen, Chang, & Wu, 2012).

The involvement of top managers in the process of increasing adoption of eco-innovation has positive influence on environmental performance, as it contributes to reduce risks and barriers for adoption, to integrate technical and market efforts. In that sense, in addition to the importance for the company, environmental managers can be also important agents in the struggle for achieving sustainable development. This is because an environmental strategy is usually connected to an increasing visibility of leading

companies and these sustainable entrepreneurs are shaping markets and society substantially (Schaltegger & Wagner, 2011).

Companies that aim at improving their environmental performance need to have managers engaged in this cause, enabling the whole team to work together toward a more sustainable operation. It is important that managers have knowledge and concerns about environmental issues (Qi *et al.*, 2010), to allow that their environmental leadership provides a shared organizational belief about the importance of adoption of eco-innovation.

As previously verified in the exploratory research, managers from food companies stated that they were moved by their own mission and philosophy for working with a product that provides health and welfare for consumers, revealing the relevance of managers' awareness (Bossle *et al.*, 2015a). These entrepreneurs see an opportunity in the market, to establish food chains that work with principles of innovation and sustainability in a market with increasing demand and lower supply (Bossle *et al.*, 2015a). Nevertheless, it is clear in their statements that there is also a personal motivation, in the case of food industry, also related to health issues. That is, companies are motivated by economic profitability when adopting eco-innovation (Dangelico & Pujari 2010; Korhonen 2001), but they are also strongly personal motivated by its founders and top managers (Bossle *et al.*, 2015a). This result is consistent with Dalcin *et al.* (2014) that identified an ideological motivation for companies working with organic and sustainable food (Dalcin *et al.* 2014).

For testing hypotheses 7a, b, c, d and e, indirect effect using bootstrapping procedures were conducted. In the proposed model, there are two direct effects on the endogenous variables environmental performance, one from the endogenous variables (actually, five, from environmental capability, environmental strategy, environmental regulation, normative pressure and technology turbulence) and another from the exogenous variable environmental managerial concern, giving to this later a status of a predictor, independent variable at the same time that this is a dependent variable. This dual role is described in SEM as an indirect or mediator effect, presumed to transmit some of the causal effects of prior variables onto subsequent variables (Kline, 2011).

Although no direct effect was found in environmental capability affecting environmental performance, there are significant indirect effects, having the hypothesis H7a being accepted and indicating a full mediation. That is, environmental capability has an influence on environmental performance through environmental managerial concern.

The same happens with the variable technology turbulence that is fully mediated by environmental managerial concern in its effect on environmental performance (H7e accepted). That is, due to the weak direct effect of technology turbulence on environmental performance, technology indirectly affects performance through its influence on environmental managerial concern.

Normative pressure has no effect, both direct and indirect, being H7c not confirmed. Environmental regulations (H7 d – supported) and environmental strategy (H7b – supported) have an influence on environmental performance that are partially mediated by environmental managerial concern, since both direct and indirect effects are significant.

These results confirm that to increase adoption of eco-innovation is crucial to integrate sustainability as an explicit goal in the organizational (Arnold & Hockerts, 2011). Managerial environmental concern can be a strong determinant of environmental innovation strategy (Eiadat *et al.*, 2008; Qi *et al.*, 2010). The achievement of organizational sustainability goals is facilitated by the presence of top managers with environmental awareness and a visionary management to integrating environmental values into organizational culture, and creating a corporate responsibility (Chen, Chang and Wu, 2012; Paraschiv *et al.*, 2012).

6. CONCLUSIONS

The main objective of this thesis was to identify how Brazilian food companies integrate innovation and sustainability, verifying what are the drivers for adoption of eco-innovation and enhancement of environmental performance. In order to accomplish that the following questions were asked: What are the conditions to integrate innovation and sustainability in the food industry, making it more environmentally pro-active? That is, what are the drivers for Brazilian food companies to adopt eco-innovations and increase their environmental performance?

These questions raised from a concern in relation to companies' environmental impact in the environment, and the need, both from a managerial and societal perspective, to reduce those negative effects that cause unprecedented damages in companies' reputation and most important, in people's life, due to the misuse of resources. It is increasing in the literature the conviction that investing in environmental strategy can be complementary to a profitable strategy (Andersen, 2004; Porter & Van Der Linde, 1995). Nevertheless, although other drivers are emerging as relevant, eco-innovation literature brings environmental regulations as the most important driver, and this can be ineffective in regions with less concern with the environment, as well as in countries and nations with weak regulations.

Before conducting the empirical investigation, the need for identifying in the literature what were these influential drivers for adoption of eco-innovation and consequently enhancement of environmental performance was accomplished with a thorough systematic literature review. This phase allowed a wider view of the field and provided a broad range of drivers and a theoretical model that contributed to better understand the dynamic of adoption of eco-innovation. Such model could also serve as a guide towards a more sustainable behaviour from companies, which usually face trade-offs when starting to invest in a new market.

This systematic literature review already brought important advancements for this theoretical field (Bossle *et al.*, 2016). Understanding what the main drivers are for adoption of eco-innovation contributes for pointing out the internal factors that companies can manage in order to fully adopt eco-innovation. While companies have limited control

of external factors, they can go beyond mere compliance when adhering to internal factors (for instance environmental capability, environmental managerial concern, and environmental strategy).

Going further on the analysis of drivers for adoption of eco-innovation, next step after identifying and developing a model from the literature review was to empirically investigate and validate these constructs and propose a final framework for investigating the Brazilian food sector. Exploratory and descriptive research with food companies allowed a deeper understand in the field, giving some hints on different scenario for Brazilian companies that were latter supported by the survey analysis.

The final model remained with seven constructs, being five exogenous (independent) constructs: environmental capability, environmental strategy, normative pressures, environmental regulations and technology. Environmental performance was defined as endogenous (dependent) and the construct environmental managerial concern that became central in this model. Environmental managerial concern plays a role as both exogenous and endogenous, fully or partially mediating the influence of the drivers over the perception of increased performance due to the adoption of eco-innovation. This is considered a very important finding of this thesis, since it represents the true power possessed by managers in the process of moving towards sustainable development. Strategic decisions are ultimately taken by people, not by companies.

All the steps followed to achieve these results, that is, methodological procedures were carefully taken into account to accurately validate constructs, whose validity and reliability were satisfactory proven in the empirical analysis. Sample size plays a key role for analysing data through structural equation analysis and the sample in this study was representative and quite big for a survey with companies.

6.1 INFLUENCE OF DRIVERS ON ENHANCEMENT OF PERFORMANCE

The empirical results from this study shed light on the drivers of eco-innovation based on a final dataset with 525 Brazilian food companies, revealing some relevant new insights. In terms of the influence of drivers to enhance the environmental performance of Brazilian food companies, it was found out that environmental performance is directly affected by environmental strategy, environmental regulations, environmental managerial concern, and very weakly, both in magnitude and in significance, by technology. In that sense, results from this sample ratify the literature, since regulations can boost eco-

innovation and this can actually contribute to companies' better performance (Azzone & Noci, 1998; Chen, Chang, & Wu, 2012; Demirel & Kesidou, 2011; Green, McMeekin, & Irwin, 1994; Horbach, 2008; Horbach, Rammer, & Rennings, 2012; Kesidou & Demirel, 2012; Oltra & Jean, 2009; Qi *et al*., 2010; Weng & Lin, 2011).

Regulations can positively influence performance, even if by forcing companies on adopting environmental friendly processes, what can generate costs, or by deviating the company from its core business in order to comply. As such, environmental regulation is also relevant as a supporter for companies, since it generates and provides knowledge by spreading environmental awareness for companies and society, helping to compensate initial costs with more valued outputs (Bergquist & Söderholm, 2011).

The role of environmental strategy and environmental managerial concern must be highlighted. Environmental strategy strongly influences adoption of eco-innovation, both positively influencing environmental managerial concern and environmental performance. Environmental strategy is crucial for companies to succeed strategically and economically, and social and environmental issues must be taken into account when developing a novelty (Medeiros *et al.*, 2014). The importance of including environmental concepts in corporate strategy and potential to succeed in the market, brings important elements for companies that want to increase production of environmental friendly products (Dangelico & Pujari 2010; Horbach 2008; Oltra & Jean 2009).

Results from this study ratifies conclusions from Azzone and Noci (1998), that eco-innovation programmes depend on management capabilities to succeed, going further by stating that managers should endorse environmental awareness and spread it throughout the company. Eco-innovation must succeed in the market to provide benefits for the company and society, by contributing to the sustainable development with higher valued products with a superior esteem for consumers (Schaltegger & Wagner, 2011).

These higher values must be created by top executives with an accentuated environmental leadership. These professionals should have the ability to besides the internal management, by integrating departments and managing eco-innovations with all other factor that influence success of the company, to cooperate with other companies, public institutions, educational bodies and other stakeholders to gather strength to the sector (Azzone & Noci, 1998).

Having that said, the need for broadening the scope of concern about eco-innovation is highlighted. There is a need for developing sustainable food chains, since eco-innovation can be an important tool to integrate partners in joint projects enabling

them to develop collaborative relationships and strategies in order to achieve sustainability along the supply chain. A company, to be considered sustainable, must integrate sustainability in its main abilities, skills and capabilities in most areas, such as corporate strategy, governance and stakeholders, clients and products, human resources and financial results (Paraschiv *et al*., 2012).

Surprisingly, environmental capability has no direct and significant effect on environmental performance, as well as technology, that only weakly influence environmental performance in the direct path. Nevertheless, both constructs have a quite significant role in environmental managerial concern, and indirect effects on performance as it is further analysed.

6.2 THE ROLE OF ENVIRONMENTAL MANAGERIAL CONCERN

Considering that companies can be considered the main responsible for environmental problems (Schaltegger & Wagner, 2011), they can also take advantage of this entrepreneurship characteristic to move forward and proactively in the search for solutions to change this eventual bad image. Environmental management is gathering importance within organizations (Chen, 2008) and it is an important driver for adoption of eco-innovation for companies in this sample, as well as the presence of an environmental leadership in the company.

Environmental managerial concern become a central concept in this study, both as an important direct influential factor for increasing companies` performance due to the adoption of an eco-innovation, and as a mediator of other important factors. Environmental managerial concern is positively influenced by environmental capability, environmental strategy, environmental regulation, and by technology.

The most important factor over environmental managerial concern in magnitude is environmental strategy (β=0,411). From this result we can infer that companies that are increasing the adoption of eco-innovations are including these actions in a strategically way, increasing chances to succeed in long term (Baumgartner & Ebner, 2010; Dangelico & Pujari, 2010).

Considering the definition of eco-innovation that is very broad and inclusive, bringing difficulties to identify those companies, it seems that this study have overcome some of these difficulties. Since some eco-innovation studies ended up selecting companies that take one-off actions, it could be seem that for companies in this sample

including environmental issues in the strategy had a great meaning both for developing a more environmental management and to increase environmental performance. That is, although taking only one-off actions may be a start, it may not be sufficient to increase eco-innovation. For this, it is necessary to include environmental issues in the strategy of the company and into environmental management concern. For companies performing in a sustainable way, they must integrate sustainability concerns into their business routines and their strategies, what can bring positive effects on society in the long term (Baumgartner & Ebner, 2010).

Environmental regulation (β=0,22) and technology turbulence (β=0,206) are significant influential factors for environmental managerial concern, as well as environmental capability of the company (β=0,165). Environmental regulation is an important trigger factor for companies to have top executives with higher concern towards the environment. That is, environmental regulation brings to the company new challenges, requiring new standards, with new and creative solutions, with high quality collaborators, top managers and strategy (Paraschiv *et al*., 2012).

The higher level of uncertainty that constantly changing in technology can bring to the market also bring to the company the need to increase its strengths in environmental management. That is, market forces tend to increase the importance of top management involvement on the innovation process and on commercialization of innovative products, and top management concern help to better integrate technical and market efforts, increasing the likelihood of success (Horbach, 2008).

The ability of the company to integrate, coordinate, build and reconfigure its competencies and resources, that is, its environmental capability play an important role on the adoption of eco-innovation through a more concerned environmental management. Although environmental capability do not have a direct effect on environmental performance, this is an important characteristic of the company, to implement an environmental managerial concern, which will significantly mediate the influence on performance.

A counter-intuitive result was the non-significant influence from normative pressure at all. Although the literature brings that eco-innovations that succeed are highly dependent on greater participation of stakeholders, emerging from cooperation between different entities, in addition to the constitution of partnerships among public sector, academia and private sector (Carrillo-Hermosilla, Del Río, & Könnölä, 2010), this factor was not important for influencing an environmental management in this sample.

This result was not in accordance with the international literature, but maybe it can be explained by some characteristics of Brazilian business environment. Traditionally in Brazil, entrepreneurs tend to work alone, by themselves, without cooperating with other companies, research institutes, government and other stakeholders (Hoffmann, Lopes, & Medeiros, 2014; Vilpoux, 2014). Lack of trust and transparency in some relationships, make business community suspicious, and led them to invest all their energy in internal capabilities, acting and deciding everything taking into account their internal perspective, letting sometimes even the opinion of direct stakeholders in a second plan.

Even though, it can be noticed a good perspective for the sector. In accordance with results from Paraschiv *et al.* (2012), companies in this sample are struggling to meet sustainable development goals through the development of eco-innovation activities. Eco-innovations helped the companies to improve performance and overall benefiting the company. In general, companies and government should increase awareness that eco-technologies can benefit the organizations that implement them and regional and national economies in general, helping to create new jobs, and to achieve the ecological objectives of sustainable development (Paraschiv *et al*., 2012).

Through partial or full mediation of environmental managerial concern, environmental capability, environmental strategy, environmental regulation and technology positively influence increasing rates of environmental performance.

6.3 IMPORTANCE FOR THE FOOD SECTOR

The importance on studying eco-innovation in the food sector can become of extremely relevance since studies in this area are very fragmented, or related to sustainable consumption, such as organic consumption, which brings some difficulties to generalize it and to extend its analysis to a broader view.

The acknowledgment of what drives food companies to adopt eco-innovation will help policy makers to develop specific actions and measures to promote environmental innovations. At the same time, for managers it can be a relevant tool to identify how they can enhance their strategies towards a more competitive management. It is becoming increasingly important for companies to raise their environmental awareness because more and more international customers and buyers are now requiring their suppliers to produce products that do not contain hazardous and toxic substances (Chiou *et al*., 2010).

Taking into consideration the complexity that sustainable and technological changes bring to the management of a food company and more broadly to the food chain, eco-innovation is clearly seen as an opportunity for the companies, and in the same time as a challenge. The challenge involves the ability of encompassing all links of the food chain, and also to make clear to the food companies what is sustainability, why to adopt and how to include environmental issues in an economic and profitable strategy (Ohmart, 2008; Santini *et al.*, 2013).

Through eco-innovations, food companies can increase their profits by adding more value to its products, through differentiation and market orientation, increasing perception of safety and health, animal welfare, awareness with environmental issues, among others (Grunert *et al.*, 2005, Vieira *et al.*, 2013). Eco-innovation can help businesses to tackle these issues and increase their ability to access new markets, enhance product quality and technical capacity, and increase profitability. In sum, eco-innovation approach can provide a win-win solution to foster economic competitiveness and sustainability.

6.4 PRACTICAL IMPLICATIONS

The importance of developing and implement public policies are extremely relevant (Chappin *et al.*, 2009) for fostering eco-innovation and sustainable entrepreneurship. Azzone and Noci (1998) highlight the importance of the role of governments to develop new campaigns aimed at increasing the level of the market environmental awareness. That is, public policies and government incentives can bring important results in this field. European Union, for example, has many incentives, both for research and applied projects. Just as an example, a report on projects run between 2008 and 2010 showed that two years after some eco-innovations projects finished, the result was savings of around 169 million m^3 of water, reductions in hazardous waste of 65 tonnes, non-hazardous waste of 609 000 tonnes, and radioactive waste of 65 tonnes, in addition to benefits in the economy. They estimated that each euro of eco-innovation grant (for business companies) yields an advantage factor of € 10 in revenues (European Union, 2013).

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. In addition, the key role of environmental management concern to boost adoption of eco-innovation and increase environmental performance raise awareness on the importance of further include sustainability in business schools' curriculum. After all, how to develop environmental leadership skills and increase environmental concern in management? Is sustainability correctly teach in Brazilian business schools? To increase concern in managers, it is necessary to raise environmental knowledge about the impact that industrial production has on the environment, not only locally, but also globally, to raise awareness about the need of such initiatives. This could be introduced, transversally throughout business schools bachelor and graduate courses.

Companies investigated in this study did not present any specific profile in terms of age, revenue or even in adoption of environmental certification, since 48% alleged to have one. Nevertheless, age and size, variables used as control variables, were significant on their influence over companies' environmental performance, indicating a slight trend for an advantage of larger and older companies. In addition, a very positive characteristic of these companies is that most of them are profitable (75%), with small or comfortable profits, having 17% stated that they are still breaking even. So, although uncertainty can be a big issue for eco-innovators (Halila & Rundquist, 2011; Tseng *et al.*, 2013), in this sample companies were quite successful, with high levels of profits. Therefore, the enhancement of product value and a possible decrease of costs due to higher efficiency (Chang, 2011), is apparently true.

Eco-innovations can be defined based on the positive effects related to its use, rather than on the environmental aim (Kemp & Pearson, 2007; OECD, 2009). Eco-innovation is the technological and organizational innovation related to the implementation of the sustainable development (Faucheux, Hue, & Nicolaï, 2006; Paraschiv et al., 2012). Therefore, applying and assimilating innovation and sustainability in business management are crucial to achieve sustainability main objectives (social, economic and environmental) (Korhonen, 2001).

6.5 THEORETICAL IMPLICATIONS

This thesis brought an innovative approach, with robust literature support via systematic review, exploratory research and test of hypotheses with structural equation modelling. This allowed to develop a comprehensive conceptual model, gathering and

investigating all relevant factors in the literature, and using those factors with parsimony in the final model for the empirical investigation. The selected drivers were previously tested in the literature but not as a whole nor to investigate its influence on environmental performance. According to Chen *et al*. (2014), insufficient research with multilevel effects has been conducted on this issue, especially in terms of empirical studies, and this thesis aimed at closing this gap.

The empirical test of the model with all the selected factors was therefore tested with a representative sample. The model fit was adequate, as well as measures used, being the model considered as meaningful and should be tested with different sectors, since theoretical assumptions are not restricted to a given sector. Therefore, with a robust theoretical framework, it was possible to use the proposed confirmatory analysis.

6.6 LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

Although this is a self-report survey, and limitations in this study can be due to the willingness of respondents to give the right answer, precautions were taken to avoid bias in that sense. Another limitation is the difficult to define boundaries to determine what the Brazilian population of eco-innovative companies is. Due to the lack of information and even the newness of the concept, it is still very difficult to identify levels of adoption and comparing companies.

Therefore, the study has some limitations that must be addressed in future research. Suggestion for future studies include testing the model with different sectors, since maybe some of the characteristics of the drivers, such as the importance of top managers' personal motivation can be a special issue from the food sector.

Considering the important role of environmental managerial concern, the profile of this entrepreneur and company's characteristics should be further investigated. What is the profile of this entrepreneur? And, is there a company's profile more suitable to eco-innovate? In addition, is it enough to single companies or entrepreneurs to eco-innovate, or is it necessary to spread concern through the development of a more sustainable value chain? Greening the suppliers and green innovation are highly related to the environmental performance of firms and their competitive advantage. Companies should therefore devote substantial efforts to address environmental issues along their supply chains in order to survive and maintain competitive advantage (Chiou et al., 2011). And

eco-innovation as an important tool to increase sustainability in sustainable supply chain should be further investigated.

Finally, this thesis is part of a bigger project, and this data collection will also be held in Europe, that is, in a more mature market. In addition, further analysis can include some moderators in the model, e.g. the construct of top management risk aversion.

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Appendix A – Questionnaire for descriptive phase

Hello!
We are researchers from the Federal University of Rio Grande do Sul, UNISINOS (Brazil) and Aarhus University (Denmark) conducting an inter-institutional, international research. This study is part of a research project sponsored by public funds, which seeks to better understand factors, motivations and drivers that can influence the adoption of environmental innovation (eco-innovation). Your participation in this study by replying to some questions below is essential, it will take approximately 25 minutes to answer!
We remind you that the anonymity of your answers is warranted, as the data collected will be analysed as a whole and never in a personalized way, while no participant will be identified in any communication or future publication, internally or externally.
Please read each statement carefully and be sure to answer all questions!
If you want to receive the results, please, let us know at the end of the questionnaire. Any further question, do not hesitate to contact us through the email: marilia.bossle@ufrgs.br or mabb@badm.au.dk
Thank you!

Eco-innovation

All questions in this survey aim to understand the process of planning and developing an Eco-innovation. Eco-innovation (Environmental, Sustainable, or Green Innovation) is the development or implementation of (new) products, process or services that creates environmental benefits. Eco-innovation can be achieved with concerns with **basic ingredients** (organic, free range,), **packaging** (i.e. recyclable), **manufacturing process** (energy saving, water recycling), **logistics or distribution** (new channels or direct consumer sales etc); certifications (traceability or origin, eco-labels, fair and solidarity trade, ISO 14001); commercial aspects (low carbon footprint etc).
Filter Question: Does your company fit in any of the cited eco-innovations?
( ) Yes ( ) No

Q1. Considering the concept of eco-innovation, did your company introduce or implement one or some of the following innovation with environmental benefits?

		Yes	No
1	Adoption of certification (**organic, bio, Demeter, biodynamic)**		
2	Adoption of **traceability or origin** labelling		
3	**Selling or production of Fair and solidarity** products		
4	Production of meat and/or eggs from **free range** animals		
5	Adoption of **recyclable or ecological packaging**		
6	Adoption / elaboration of **environmental reports**		
7	**Environmental Management and auditing systems**: formal Environmental Managemet Systems for measuring, reporting and designating responsibles for dealing with issues related to the use of materials, energy, water and waste. E.g.: **EMAs and ISO 14001**.		
8	**Reduction of material** use per unit of output **within my enterprise**		
9	**Reduction of energy** use per unit of output **within my enterp**rise/adoption of renewable energy		
10	**Reduction of CO2 'footprint'** (reduction of total CO2 production) by my enterprise		
11	**Replacement of materials with less polluting or hazardous substitutes** within my enterprise		
12	**Reduction of water, air pollution, soil or noise** within my enterprise		
13	**Management and Recycling waste, water,** or materials within my enterprise		
14	**Sustainable distribution channels**		
15	**Other? Please specify:**		

Internal Factors

Q. 2. Please, assess the following information, you can answer with a number between 1 and 5, where 1 means "Strongly disagree" and 5 means "Strongly agree", or any intermediary number between 1 and 5, according to the following statement: The company's abilities to integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations are…..

		Strongly disagree				Strongly agree
1	**Outstanding.** EC1	1	2	3	4	5
2	**Rare in marketplace.** EC2	1	2	3	4	5
3	**Less imitable by competitors.** EC3	1	2	3	4	5
4	**Difficult to be substituted.** EC4	1	2	3	4	5

Q. 3. To what extent do you agree with the following **in relation to the adoption of an eco-innovation.** You can answer with a number between 1 and 5, where 1 means "Strongly disagree" and 5 means "Strongly agree", or any intermediary number between 1 and 5.

		Strongly disagree				Strongly agree
1	The leaders within the company inspire a shared vision of the organization as environmentally sustainable, creating or maintaining green values throughout the company. EMC1	1	2	3	4	5
2	The leaders within the company utilize well-developed approaches to environmental management which generally center around a program customized to the company's specific business and market. EMC2	1	2	3	4	5
3	The leaders within the company create partnerships with the company's stakeholders to solve environmental problems and to accomplish environmental goals. EMC3	1	2	3	4	5
4	The leaders within the company can take on the responsibility of environmental education with the intent of engaging employees in environmental management initiatives. EMC4	1	2	3	4	5
5	Environmental innovation is necessary to achieve high levels of environmental performance. EMC5	1	2	3	4	5
6	Environmental innovation is an important component of the company's environmental management strategy. EMC6	1	2	3	4	5
7	Most environmental innovations are worthwhile. EMC7	1	2	3	4	5
8	Environmental innovation is an effective environmental management strategy. EMC8	1	2	3	4	5

Q.4. Please, assess **the importance of the following statements for the adoption of eco-innovation by your company.** You can answer with a number between 1 and 5, where 1 means "not important at all" and 5 means "Very important", or any intermediary number between 1 and 5.

		Not Important at all				Very Important
1	Importance of personnel commitment to environmental matters for adoption of an eco-innovation. HR1	1	2	3	4	5
2	Importance of personnel motivation for adoption of an eco-innovation. HR2	1	2	3	4	5
3	Importance of training for sustainability approach for adoption of an eco-innovation. HR3	1	2	3	4	5
4	Importance of top management to encourage employees to learn green practices for adoption of an eco-innovation. HR4	1	2	3	4	5

External Factors

Q. 5. Please indicate the extent to which **you agree or disagree with the following statements and its influence on the adoption of eco-innovation**. You can answer with a number between 1 and 5, where 1 means "Strongly disagree" and 5 means "Strongly agree", or any intermediary numbers between 1 and 5.

		Strongly disagree				Strongly agree
1	Recently my company **introduced an eco-innovation in response to existing environmental regulations or environmental taxes**. ER1	1	2	3	4	5
2	Recently my company **introduced an eco-innovation in response to environmental regulations or taxes that are expected to be introduced in the future** ER2	1	2	3	4	5
3	Environmental laws and regulations that impact my company **contain stringent standards**. ER3	1	2	3	4	5
4	Environmental laws and regulations that impact my company **are appropriate for my country's circumstances**. ER4	1	2	3	4	5
5	Environmental laws and regulations that impact my company **are clear**. ER5	1	2	3	4	5
6	Environmental laws and regulations that impact my company **are effective in tackling environmental problems directly**. ER6	1	2	3	4	5

Q. 6. How important do you consider the influence of the following groups on the decision to adopt eco-innovation in your company?

	The importance of the demand/pressure from (….groups below….) for adoption of eco-innovation was … (1 if "not Important at all"; 5 if "very Important", or any intermediary number between 1 and 5).	Not Important at all				Very Important
1	From **Public authorities (government, state, municipal)** NP1	1	2	3	4	5
2	From **Corporate headquarters** NP2	1	2	3	4	5
3	From **Household consumers/clients** NP3	1	2	3	4	5
4	From **Commercial buyers** NP4	1	2	3	4	5
5	From **Suppliers of goods and services** NP5	1	2	3	4	5
6	From **Shareholders and investment funds** NP6	1	2	3	4	5
7	From **Banks and other lenders** NP7	1	2	3	4	5
8	From **Management employees (Top executives; Top Managers)** NP8	1	2	3	4	5
9	From **Non-management employees (Employees)** NP9	1	2	3	4	5
10	From **Labour unions** NP10	1	2	3	4	5
11	From **Industry or trade associations** NP11	1	2	3	4	5
12	From **Environmental groups or organisations** NP12	1	2	3	4	5
13	From **Neighbourhood/community groups & organisations** NP13	1	2	3	4	5
14	From **Competitors** NP14	1	2	3	4	5
15	From **International partners** NP15	1	2	3	4	5

Q. 7. Please indicate to what extent you agree with the following statements and its influence on the adoption of eco-innovation by your company. You can answer with a number between 1 and 5, where 1 means "Not at all" and 5 means "To a great extent" or any intermediary number between 1 and 5.

		Not at all				To a great extent
1	Government provides financial support for adopting eco-innovation. GP1	1	2	3	4	5
2	Government provides technical assistance for adopting eco-innovation. GP2	1	2	3	4	5
3	Government helps training manpower with green skills for eco-innovation. GP3	1	2	3	4	5

Q. 8. Please, indicate the importance of collaboration with the following agents on adoption of an eco-innovation by your company. You can answer with a number between 1 and 5, where 1 means "Not Important at all" and 5 means "Very Important", or any intermediary number between 1 and 5.

		Not Important at all				Very Important
1	Importance of collaboration **with customers/consumers/clients** for developing/adopting an eco-innovation	1	2	3	4	5
2	Importance of collaboration **with suppliers**	1	2	3	4	5
3	Importance of collaboration **within your company**	1	2	3	4	5
4	Importance of collaboration **with competitors or other enterprises of the same industry**	1	2	3	4	5
5	Importance of collaboration **with university, research centre or other higher education institutions**	1	2	3	4	5
6	Importance of collaboration **with government**	1	2	3	4	5
7	Importance of collaboration **with professional and industrial associations**	1	2	3	4	5
8	Importance of collaboration with other groups or organisations (please specify)_____	1	2	3	4	5

Performance, Motivations and Strategy

Q. 9. Indicate the **effects that the adoption of an eco-innovation had in the performance of your company**. You can answer with a number between 1 and 5, where 1 means "substantial negative effect" and 5 means “substantial positive effect”, or any intermediary number between 1 and 5.

		substantial **negative**				substantial **positive**
1	The effect of the adoption of eco-innovation **on market share** was... P1	1	2	3	4	5
2	The effect of the adoption of eco-innovation **on sales growth** was... P2	1	2	3	4	5
3	The effect of the adoption of eco-innovation **on return on investment** was…. P3	1	2	3	4	5
4	The effect of the adoption of eco-innovation **on environmental performance** was…. P4	1	2	3	4	5
5	The effect of the adoption of eco-innovation **on economic performance** was…. P5	1	2	3	4	5

Q. 10. Please indicate the level of agreement with the following statements. You can answer with a number between 1 and 5, where 1 means "Strongly Disagree” and 5 means "Strongly Agree", or any intermediary number between 1 and 5.

		Strongly Disagree				Strongly Agree
1	Top managers in this company believe that higher financial risks are worth taking for higher rewards.	1	2	3	4	5
2	Top managers in this company accept occasional new product failures as being normal.	1	2	3	4	5
3	Top managers in this company encourage the development of innovative marketing strategies, knowing well that some will fail.	1	2	3	4	5
4	Top managers in this company like to act boldly."	1	2	3	4	5
5	Top managers in this company decide to implement plans even if they are not certain that they will work.	1	2	3	4	5
6	The technology in our industry is changing rapidly. T1	1	2	3	4	5
7	Technological changes provide big opportunities in our industry. T2	1	2	3	4	5
8	It is very difficult to forecast where the technology in our industry will be in the next 2 to 3 years. T3	1	2	3	4	5
9	A large number of new product ideas have been made possible through technological breakthroughs in our industry. T4	1	2	3	4	5
10	Technological developments in our industry are rather major. T5	1	2	3	4	5

Q. 11. Please indicate the level of agreement with the factors related to the strategy of your company. You can answer with a number between 1 and 5, where 1 means "Strongly Disagree" and 5 means "Strongly Agree", or any intermediary number between 1 and 5.

		Strongly Disagree				Strongly Agree
1	Our firm has integrated environmental issues into our strategic planning process. ST1	1	2	3	4	5
2	At our firm, quality includes reducing the environmental impact of products and processes. ST2	1	2	3	4	5
3	At our firm we make every effort to link environmental objectives with our other corporate goals. ST3	1	2	3	4	5
4	Environmental issues are always considered when we develop new products. ST4	1	2	3	4	5

Q. 12. Please, indicate how important are the following motivations regarding environmental practices and eco-innovation in your company. You can answer with a number between 1 and 5, where 1 means "not important at all" and 5 means "Very important", or any intermediary number between 1 and 5.

		Not important at all				Very important
1	Prevention or control of environmental incidents	1	2	3	4	5
2	Regulatory compliance	1	2	3	4	5
3	Amelioration of Corporate profile/image	1	2	3	4	5
4	New product or technology development	1	2	3	4	5
5	Facilities similar to ours are adopting similar practices	1	2	3	4	5
6	Cost savings through better use of materials/energy in process.	1	2	3	4	5
7	Change in supplied components.	1	2	3	4	5
8	Increased efficiency through equipment upgrade.	1	2	3	4	5
9	Adoption of a certification.	1	2	3	4	5
10	Adoption of an Environmental Management System.	1	2	3	4	5
11	Adoption of Corporate Social Responsibility (CSR) practices.	1	2	3	4	5

COMPANY'S CHARACHTERISTICS

Q. 13. Number of persons employed: _____
Q. 14. In what year was your firm stablished? _____
Q. 15. Does your company have an environmental certification? (1) Yes (2) No
If yes, can you specify? _____**Q.16 . How would you assess your company's overall business performance over the past three years? (Please tick only one box.)**
(1) Revenue has been so low as to produce large losses.
(2) Revenue has been insufficient to cover costs.
(3) Revenue has allowed us to break even.
(4) Revenue has been sufficient to make a small profit.
(5) Revenue has been well in excess of costs.
Q. 17. Please, provide your firm revenue in 2013 (total turnover: market sales of goods and services include all taxes): (see values in EUROS)
(1) R$ 2,4 milhões or less
(2) More than R$ 2,4 milhões up to R$ 16 milhões
(3) More than R$ 16 milhões up to R$ 90 milhões
(4) More than R$ 90 milhões up to R$ 300 milhões
(5) More than R$ 300 milhões
Q. 18. Please estimate your company's annual expenditures on research and development over the last three years? _____ **(Please, write the amount per year)**
Q.17. Does your firm have a budget for research and development specifically related to environmental matters?
( ) YES ( ) NO

Company's Name _____
State
Name of the respondent _____
Position in the company (respondent's)_____**Would you like to receive the results through email? (1) Yes (2) No**
E-mail _____
Telephone number _____
Are there any comments that you would like to make (including reporting on other actions you may have taken to reduce impact of your company's activities on the environment)?

Appendix B – In-depth interviews instrument

A OCDE definiu eco-inovação como "a criação de produtos (bens e serviços), processos, métodos de marketing, estruturas organizacionais e arranjos institucionais novos ou significativamente melhorados, que - com ou sem intenção - levam a melhorias ambientais em comparação com outras alternativas relevantes" (OCDE, 2008 p 19). Neste projeto, definimos eco-inovação nos mesmos termos da OCDE, porém acrescentamos as melhorias éticas e sociais ao construto. Assim, alimentos eco-inovadores seriam aqueles dotados de apelos éticos/sociais/ambientais, que visam atender às demandas dos consumidores por este tipo de produto em específico e que são produzidos a partir de critérios de produção bem estabelecidos.

1. Quais são os principais motivadores para a sua empresa investir e desenvolver produtos eco-inovadores no setor de alimentos (apelos éticos/sociais/ambientais)?
2. De uma maneira geral, como você percebe a oferta de alimentos com apelo social e ecológico? Consegue fornecedores?
3. Quais são as características do consumidor que busca alimentos que tenham apelo ético/social e ambiental? Você percebe alguma mudança nos valores, nas necessidades, na consciência ambiental dos consumidores? Explique.
4. Quais são os fatores que influenciam os consumidores a aceitar as inovações em alimentos?
5. Na sua opinião, a incorporação de tecnologia em um alimento torna ele mais ou menos sustentável? Por quê? Qual a relação entre tecnologia e sustentabilidade?
6. Como é o processo de criação de uma inovação na sua empresa? Esse processo é determinante para o sucesso de um produto?
7. Você poderia nos contar a história de algum produto eco-inovador ou mudança em processo que marcou a empresa pelo sucesso ou fracasso?
8. Quais são as principais tendências de mercado para alimentos eco-inovadores no Brasil? E quais as maiores dificuldades?
9. Existe algum apoio governamental para a eco-inovação? Influências do mercado externo? Da sociedade?
10. Existe relação entre a competitividade de um determinado mercado e a difusão e implementação de inovações?
11. Você acha que o homem está em equilíbrio com a natureza? Comente.