TESIS DOCTORAL

KNOWLEDGE MANAGEMENT AND DYNAMIC CAPABILITIES: FOUR ESSAYS ON THEIR RELATIONSHIP AND INFLUENCE ON GREEN INNOVATION

Doctorando:
Gema Albort Morant
UNIVERSIDAD DE SEVILLA
Departamento de Administración de Empresas y Comercialización e Investigación (Marketing)

Directores:
Prof. Dr. D. Gabriel Alfonso Cepeda Carrión. UNIVERSIDAD DE SEVILLA
Prof. Dr. D. Jörg Henseler. UNIVERSITY OF TWENTE

SEVILLA, 2017

GRATITUDE

GRATITUDE

En primer lugar, me gustaría agradecer sinceramente a mis directores, el profesor Dr. D. Gabriel Cepeda Carrión y el profesor Jörg Henseler por su esfuerzo y dedicación. Sus conocimientos, su orientación, su paciencia y su motivación han sido fundamentales para mi formación como investigadora. También me gustaría dar las gracias a mi tutor, el profesor Dr. D. Antonio Leal Millán por dedicarme su valioso tiempo, su experiencia, sus consejos y por el empeño que ha puesto en este trabajo. A su manera, ellos han sido capaces de ganarse mi admiración y lealtad, y no puedo sino sentirme en deuda por todo cuanto he recibido durante el periodo de tiempo que ha durado mi Tesis Doctoral.

Tampoco puedo olvidarme de la persona que me introdujo en este mundo, el profesor Dr. D. Domingo Ribeiro Soriano, por inculcarme valores que me han permitido crecer como persona e investigadora, así como del GIKA team por tantos momentos vividos juntos.

A mis compañeros del Departamento de Administración de Empresas e Investigación de Mercados (Marketing) de la Universidad de Sevilla, por su atención y amabilidad en todo lo referente a mi vida como alumna de doctorado. Quisiera agradecer especialmente los consejos, el apoyo y las sonrisas de compañeros como Lucía Rodríguez Félix, José Luis Roldán Salgueiro y Jaime Ortega Gutiérrez.

Por último, mi especial agradecimiento a mi familia y amigos a los que he robado horas de compañía. Gracias por aguantar mis agobios y ausencias durante todo este tiempo. Quisiera dar especialmente las gracias a mi padre, Antonio Alberto y la abuelita, por confiar siempre en mí a pesar de su desconocimiento de este mundo tan complicado. Os pido perdón por tantos viajes a Valencia en los que estuve ausente y pegada al ordenador.

Y como no, a Antonio Luis, por ser mi guía, mi confidente, mi gran apoyo, mi compañero de vida. Esta tesis es tuya también. Te quiero.

A todos, GRACIAS.

“El futuro pertenece a aquellos que creen en la belleza de sus sueños”
Eleanor Roosevelt

“No creo que haya otra cualidad más importante para el éxito que perseverar.
La perseverancia supera casi todo, hasta la propia naturaleza”
John D. Rockefeller

El somriure d’un àngel mai s’oblida.
G. M. L.

INDEX

INDEX OF CONTENT

INDEX OF FIGURES

INDEX OF TABLES

CHAPTER 1

Introduction, Objectives and Sample Overview

CHAPTER 1: Introduction, Objectives and Sample Overview

1.1. Relevance and justification of the research

Environmental impact has become a global growing concern in the current business context and for society in general, including consumers, firms, policy-makers and stakeholders of a diverse nature. For this reason, to survive inside the current conjuncture marked by highly dynamic, volatile and hypercompetitive scenarios, companies must adopt and promote strategies aimed at encouraging innovative approaches to production and sustainability.

Increasing social concern and environmental regulations are contributing significantly to making a large number of companies carry out strategies emphasizing green innovation that allow them to guarantee their long-term survival and increase their yields (LaForet, 2009).

Companies must therefore make an effort to keep abreast of the changes, fluctuations and trends that are gradually emerging in the market. This implies being geared to the demands of their main customers and interest groups, and proactively developing a strategy oriented toward sustainability.

The increasing demands of society in environmental matters are forcing firms to participate in ecological issues through systematic actions that enable them to attain their social, environmental and economic targets.

There are two main dynamic forces that encourage environmental management (Chen, 2008): (i) an international set of standards and rules relative to the safety of the environment, and (ii) the increasing ecological awareness of customers (Chen, Lai and Wen, 2006). Whatever the objectives that lead firms to carry out an ecofriendly management of their operations, the integration of environmental and sustainability issues into their corporate strategy and the ecological orientation of the innovation process is becoming a strategic matter for firms (Porter et al., 2007). Consequently, as noted in some studies, environmental management and green practices are closely linked to business innovation (Aragón-Correa, 1998; Perez-Valls et al, 2015).

In this line, the firms that are pioneers in the generation of green innovation approaches will be able to remain competitive. Therefore, the success of green innovation performance (GIP) supports firms to attain superior efficacy, besides founding and fortifying their basic skills, and to improve their green image. Subsequently, this will allow companies to achieve higher performance and greater profitability (Chen, 2008).

This dissertation tries to shed some light on this field of study. To do so, it firstly accomplishes an in-depth study of the green innovation variable, which at present is very important and is of great interest to researchers and practitioners or managers.

This thesis is composed of four essays: a bibliometric analysis on green innovation that will allow us to understand and go deeper into the study of this variable, and the three essays or empirical works that intend to detect possible variables that can act as drivers of green innovation performance.

In our thesis, we analyze possible drivers of this variable that can affect its final performance. The variables analyzed are dynamic capabilities, the firm's knowledge base, the firm's absorptive capacity and relationship learning. These are variables of much interest for both academics and professionals, being taken into account in defining the managerial strategy to pursue.

The main contributions extracted from this study are at both the academic and the enterprise level since it aims to add to the literature by trying to identify the possible combinations between the different organizational capabilities proposed. First, it analyzes in depth the existing literature on green innovation performance, as well as the relationships between dynamic capabilities, relationship learning and green innovation performance. Secondly, it proposes to find out how relationship learning favors an increase in green innovation performance. Finally, in the third essay, we go further by dividing green innovation performance into green product innovation and green process innovation, and explaining the relationship between the two constructs of absorptive capacity –potential and realized absorptive capacity– with green product and process innovation. In this vein, this study links the firm's knowledge and capabilities with the current business concern for green innovation performance, and means to understand how relationship learning affects this relation. This leads to the presentation of notable conclusions and managerial implications.

Finally, this dissertation is an interesting topic for the following reasons: 1) for its innovation, given that the topic has been scarcely addressed in the literature, 2) for its topicality, since the variables grouped together in the model are of great interest to the researchers in the field of business management; and 3) for its potential contribution, as the outcomes of this study might improve the current management of firms by guiding them toward the creation of superior value for the customer.

1.2. Objectives of the Thesis

Although several scholars have attempted to understand and explore the green innovation topic, even its more essential aspects have not been clarified yet, including the delineations or types of innovation and its dimensions. The extensive diversity of studies increases the strength and affluence of research on green innovation but also leads to certain misunderstanding concerning the construct's meaning and utility.

Hence, the main objective of this thesis is to try to understand in depth the concept of green innovation performance, as well as to ascertain what are actually the variables –dynamic capabilities, knowledge base, absorptive capacity and relationship learning– that may act as fundamental drivers that affect the performance of this variable.

Accordingly, we focus our study with the target of answering the following research questions, which we will group into four blocks:

Question 1: What are the conceptual roots of the green innovation variable?

Question 2: To what extent do the existing internal capabilities of firms and their interaction with external knowledge sources —relationship learning enhancement —affect the level of green innovation performance?

Question 3: How does the presence of relationship learning actually affect the link between a firm's knowledge base and green innovation performance?

Question 4: How does a firm's potential absorptive capacity influence realized absorptive capacity? How does a firm's potential absorptive capacity influence the creation of green innovation through processes and products? How does a firm's realized absorptive capacity influence the creation of green innovation through processes and products?

In order to make this ambitious objective more attainable, we have divided this study into a set of more simple objectives, which we have formulated as follows:

- To clarify the concept of green innovation, as well as the concept of dynamic capabilities, knowledge base, absorptive capacity and relationship learning.
- To identify and select the different dimensions that shape the constructs used in our study.

- To assess the antecedents and variables that act as drivers of or reinforce a firm's green innovation performance.
- To empirically test the research hypotheses.
- To draw conclusions that may help both researchers and managers to better understand the potential benefits that they could obtain from the development of dynamic capabilities and knowledge management related strategies in the path of greening their business activity and enhancing performance.

Having achieved our research objectives, these will allow us to contribute to the field of business management helping both academics and practitioners to take into account and to understand the potential benefits of environmental management. On the one hand, we will have done an extensive review of the previous literature by a bibliometric analysis. This is a discipline that consists of applying statistical methods to evaluate knowledge developments in a specific subject. On the other hand, this study contributes to the empirical development of these lines of research. To perform the data analysis we have used Partial Least Squares (PLS) path-modeling, a variance-based structural equation modeling technique with broad implementation and acceptance within social sciences research.

1.3. Sector Overview

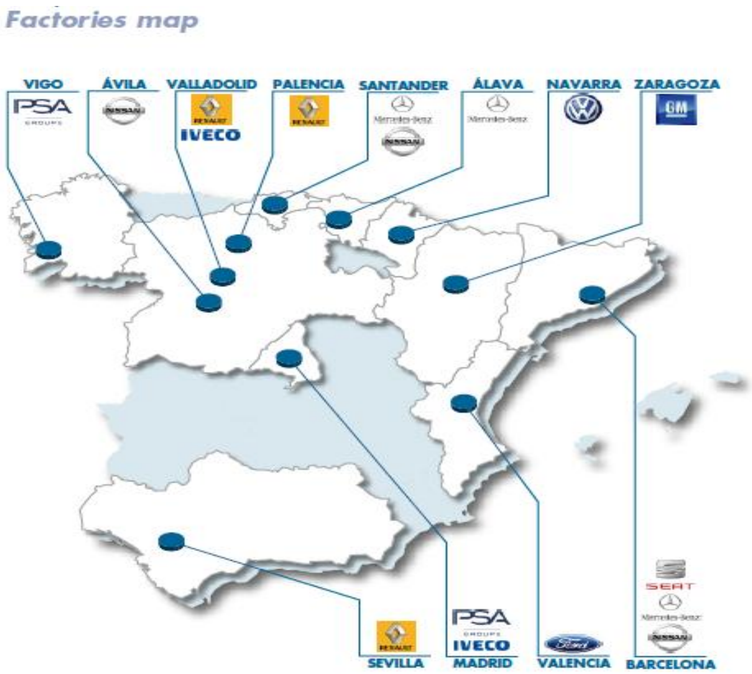
The main companies within the automotive industry are currently struggling to design and produce vehicles that minimize carbon emissions and which could use more efficient energies. This would permit the vehicles to reduce pollution. However, to make this happen, the companies in the sector must have environmental knowledge and capabilities that allow them to adapt to the environmental requirements.

Therefore, companies of the automotive sector must make an effort together with their suppliers, since these are the ones who manufacture the majority of vehicle components. The companies in the sector of automotive components must be informed at all times of the needs and requirements of their customers to suit their demands.

We have decided to use in our study a sample of the Spanish automotive components manufacturing sector (ACMS). The reason for this decision is based on the consideration of this sector as an innovative and knowledge-intensive industry. These companies are characterized by the capacity of adaptation to the diversity of the technological, environmental and corporate culture of their customers –the different manufacturers of vehicles–. Within the automotive sector it is becoming especially important to be able to develop new technologies or innovations concerning the production processes to face a globalized world and to remain competitive.

For this reason, the impulse generated by vehicle manufacturers is transforming the automotive sector into a key element for the country's economic and social development. Spain's automotive sector is also a world referent, holding 2nd position among European car manufacturers, behind Germany, and 8th position worldwide. During the year 2015, 2,733,201 vehicles were made in Spain, and more than 2 million of vehicles were exported through the 17 manufacturing plants of vehicles -Ford, Renault, Mercedes, Nissan, Renault, Peugeot, Opel, Iveco, Seat, Citroën- located throughout the country (Figure 1).

Figure 1. Map of the automotive factories in Spain



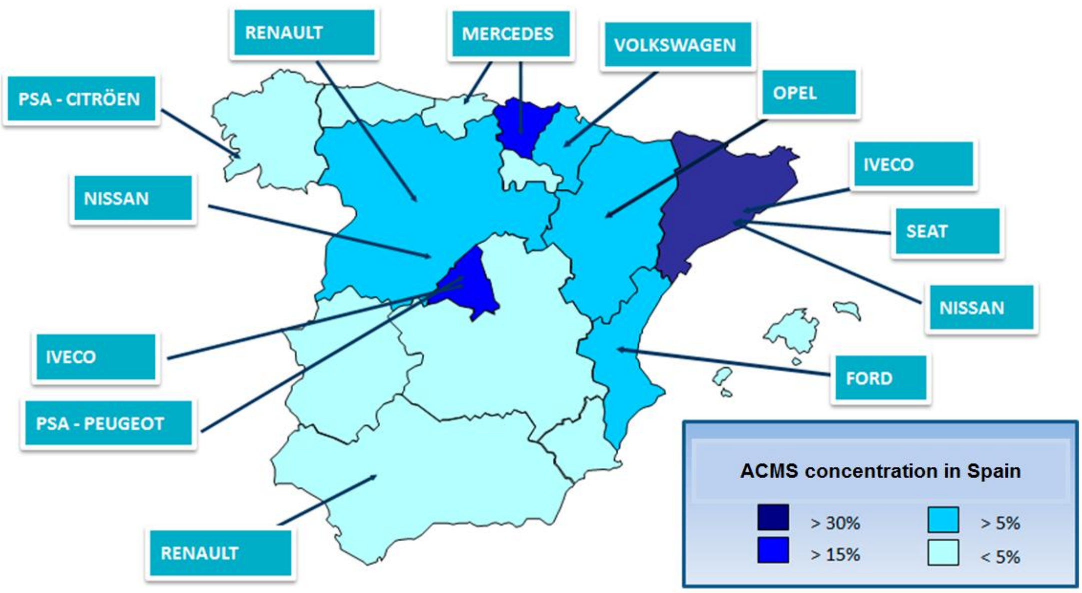
Source: Sernauto (2015)

The ACMS is made up of around 1,000 companies which are manufacturers of equipment and components and up to 730 business groups are installed in Spain, ensuring the service and supply of the car manufacturing plants (Sernauto, 2015). These companies have a turnover of more than 32,000 million components in 2015 and employ 204,200 people distributed geographically throughout the country, representing more than 5% of industry employment in 10 Autonomous Communities (ANFAC, 2015).

They generate 6,600 million euros of GVA (gross value added), more than half of the automotive sector and equivalent to 4% of the industry's total GVA. Also, the industry activity of the sector provides fiscally 4,660 billion euros in value added tax (VAT), Social Security, people's income tax and corporation tax. Hence, the powerful Spanish industry of components is one of the factors that all experts point out at the time of explaining the strength of the automotive sector in Spain.

The sector is grouped around Sernauto (www.sernauto.es). Sernauto is the Spanish Association of Manufacturers of Equipment and components for the automotive industry (Figure 2). Its associated companies represent more than 85% of the invoicing of the sector to the Administration and entities and public and private institutions, gathering together large national and international groups, capitalized companies and SMEs (Sernauto, 2015). In the Appendix section it can be found the population of firms that compose the ACMS in Spain.

Figure 2. ACMS concentration in Spain



Source: Sernauto (2015)

1.4. Thesis Structure

This thesis has been organized in the following way. Chapter 1 constitutes the present chapter of introduction and overview. In Chapter 2, we perform a deep theoretical review of the main constructs that make up this work, as well as the dimensions that form them. Chapters 3, 4, 5 and 6 collect a theoretical study and three scientific essays written in this thesis. And finally, Chapter 7 shows the general and particular conclusions and contributions. Subsequently it is provided a description of the contents of each of the above-mentioned chapters.

In Chapter 2, we carry out a review of the major contributions that the scientific literature has made in the fields of green innovation (GI), dynamic capabilities (DC), knowledge base (KB), absorptive capacity (ACAP), and relationship learning (RL). In doing so, we have tried to find the theoretical background underlying the different constructs that are approached in this study. We gather the different definitions that the literature provides for these constructs, and propose a definition that integrates the main prior contributions.

Chapter 3 develops a bibliometric analysis of the green innovation topic with the purpose of assessing the key publications in the field and categorizing the most essential contributions in the literature. This study provides insights concerning: (i) the journal with the highest number of articles; (ii) the countries with most publications; (iii) the most prolific authors on the topic; (iv) the antecedent variables acting as key drivers of GI in these studies; (v) the research trends and popular issues; and (vi) the main outcomes in this field of study.

Chapter 4 is focused on the dynamic capabilities (DC) and ordinary capabilities (OC) as precursors of green innovation performance (GIP), and the links existing between these constructs. The study tests the existence of a mediation role to examine both the direct and indirect relationships.

In Chapter 5, we have hypothesized the positive connection between relationship learning (RL) and green innovation performance (GIP). Subsequently, a second step involves the consideration of whether the firm's knowledge-base (KB) exerts a mediating role in the RL-GIP link.

Chapter 6 presents the positive relationship between absorptive capacity (ACAP) and green innovation performance (GIP). On the basis of Zahra and George's (2002) conceptualization of absorptive capacity, this chapter addresses these two dimensions –potential and realized absorptive capacity– separately, and studies their influence on the two dimensions of green innovation performance –green product and process innovation– within organizations.

Finally, Chapter 7 presents the general discussion of the results as well as the conclusions, implications –both at the academic and the managerial level– and limitations of this study. The chapter ends by establishing several lines of research that we aim to develop in the future in order to enhance and improve this thesis.

1.5. References

Anfac (2015). Annual memory 2015. http://www.anfac.com/documents/tmp/MemoriaANFAC2015.pdf

Aragón-Correa, J. A. (1998). Strategic proactivity and firm approach to the natural environment. *Academy of Management Journal, 41*, 556-567.

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics, 67*(4), 331-339.

Chen, Y. S. (2008). The driver of green innovation and green image–green core competence. *Journal of Business Ethics, 81*(3), 531-543.

Laforet, S. (2009). Effects of size, market and strategic orientation on innovation in non-high-tech manufacturing SMEs. *European Journal of Marketing, 43*(1/2), 188-212.

Pérez-Valls, M., Céspedes-Lorente, J., & Moreno-Garcia, J. (2015). Green Practices and Organizational Design as Sources of Strategic Flexibility and Performance. Business Strategy and the Environment, Published online EarlyView in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/bse.1881.

Porter, M., & Reinhardt, F. L. (2007). A Strategic Approach to Climate. *Harvard Business Review, 85*(10), 22–26.

Sernauto (2015). Annual memory 2015. http://www.sernauto.es/images/memorias_sernauto/2015/

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185-203.

CHAPTER 2

Theoretical Foundations

CHAPTER 2: Theoretical Foundations

2.1. Theoretical foundations of Green Innovation Performance

2.1.1. Delimitation of the concept of innovation

Innovation has become a recurrent topic, often referred to as an authentic cornerstone and critical asset for every single organization and for society in general terms. The search in Google Scholar for the term “innovation” offers a total of 3.690.000 results. To put this outcome in context, the search for “entrepreneurship” and “organizational culture” provide 1.290.000 and 2.600.000 results, respectively. This result reveals the high influence and attention captured by the innovation topic for academics. The search in Google of the “innovation” term yields 3.690.000 results. This illustrates the great significance of this concept also has for practitioners.

Certainly the term innovation is mentioned in masses of books, research papers and websites. It entitles and gives meanings to conferences, and both professional and academic meetings. It shapes government’s strategies and public policies. Overall, it has lately become a strategic priority for managers. Moreover, this term goes beyond the managerial literature and is included by an extensive variety of disciplines, for example marketing, communication, psychology, sociology, engineering, etc. (Johannessen et al., 2001).

Nevertheless, and despite the high popularity attained by this term, it is still a complex task to delimit and provide a full, comprehensive and significant definition of innovation. The paragraphs below aim to clarity the concept of innovation, gathering some noteworthy definitions and proposing an integrative new definition.

Innovation is frequently viewed as the act of changing or altering something by introducing some novelty. Due to the relevance of promoting innovation at a regional level, several institutions have attempted to provide their own definition.

In the academic ambience, the first definition that must be known is that of Schumpeter who indicates that innovation is the driving force of economic development since there is not a single possible innovation, but the new combinations of five productive strengths: i) introduction of new goods; ii) introduction of a new method of production; iii) opening of a new market; iv) conquest of a new source of raw material; or v) execution of a new form of industrial engineering (Schumpeter, 1934, p.66). In this definition Schumpeter always talks about products and industry, since, at that time, the Second Industrial Revolution was taking place and the most dramatic changes occured in industry.

From the 1980s the word innovation has strongly resurfaced in the academic and political scenes. Since then there have been many scholars from various approaches who have attempted to define and refine its meaning. Innovation is the set of activities inscribed in a period of time and a place that lead to the successful introduction of an idea in the form of new or improved products and/or services in the market (Pavon and Goodman, 1981). The author Kimberly (1981) noted that there are three stages of innovation: i) innovation in process; ii) innovation in products, programs and services; and iii) innovation as an aspect of firms.

For instance, the European Union (1995), in their Green book of innovation, conceptualizes it as the process of producing, assimilating, managing and successfully introducing novelty within the social and economic spheres. Besides, the Oslo manual of OECD-Eurostat (2005) labels innovation as the introduction of a new, novel or significantly enhanced product, service or process, or the introduction of a new commercialization or managerial method applied to business practices, the organization of labor or external relationships.

All these definitions, together with those found in Table 1, have many things in common. In the first place, innovation is much more than new products or services. It is the result of a series of activities that require more time and involve more risk than other productive activities. Secondly, the definitions agree that innovations must be introduced successfully. Finally, innovation will be considered as such when the product, process, business method or organizational is new or significantly improved for the company that puts it into practice.

Table 1. List of innovation definition

References	Definition
Schumpeter (1942, p. 83)	Process of industrial mutation (...) that incessantly revolutionizes the economic structure from within
Thompson's (1964, p. 2)	Innovation is the generation, acceptance and implementation of new ideas, processes, products or services
Zaltman et al. (1973, p. 10)	Any idea, practice, or material artifact perceived to be new by the relevant unit of adoption
Kimberly (1981, p. 108)	There are three stages of innovation: innovation as a process, innovation as a discrete item including, products, programs or services; and innovation as an

	attribute of organizations
Damanpour (1991, p. 556)	The generation, development, and adaption of novel ideas on the part of the firm
Zahra and Covin (1994, p. 183)	Innovation is widely considered as the life blood of corporate survival and growth
European Commission (1995). Green paper on innovation	Innovation is the process of producing, assimilating, managing and successfully introducing novelty within the social and economic spheres
Damanpour (1996, p. 694)	Innovation is conceived as a means of changing an organization, either as a response to changes in the external environment or as a pre-emptive action to influence the environment. Hence, innovation is here broadly defined to encompass a range of types, including new products or services, new process technology, new organization structure or administrative systems, or new plans or programs pertaining to organization members
Oslo Manual (1997, p. 31)	Implemented technologically new products and processes and significant technological improvements in products and processes
Rogers (2003, p. 1)	An innovation is an idea, practice or object perceived as new by an individual or other unit of adoption
Bessant et al. (2005, p. 1366)	Innovation represents the core renewal process in any organization. Unless it changes what it offers the world and the way in which it creates and delivers those offerings it risks its survival and growth prospects
Oslo Manual's (2005)	Innovation is not an end in itself but a means for growing production and productivity
Damanpour and Schneider (2006, p. 216)	Innovation is studied in many disciplines and has been defined from different perspectives
Freeman and Engel (2007, p. 94)	Innovation refers to a process that begins with a novel idea and concludes with market introduction
Plessis (2007, p. 21)	Innovation as the creation of new knowledge and ideas to facilitate new business outcomes, aimed at improving internal business processes and structures and to create market driven products and services. Innovation encompasses both radical and incremental elements
Wong et al. (2008, p. 2)	Innovation can be defined as the effective application of processes and products new to the organization and designed to benefit it and its stakeholders
Leal-Rodríguez et al. (2013)	Innovation is essentially about converting ideas into something profitable, encouragement to supply ideas needs to be substantial in order to channel the creative ability of the employees to convert ideas into innovations

2.1.1.1. Attributes of innovation

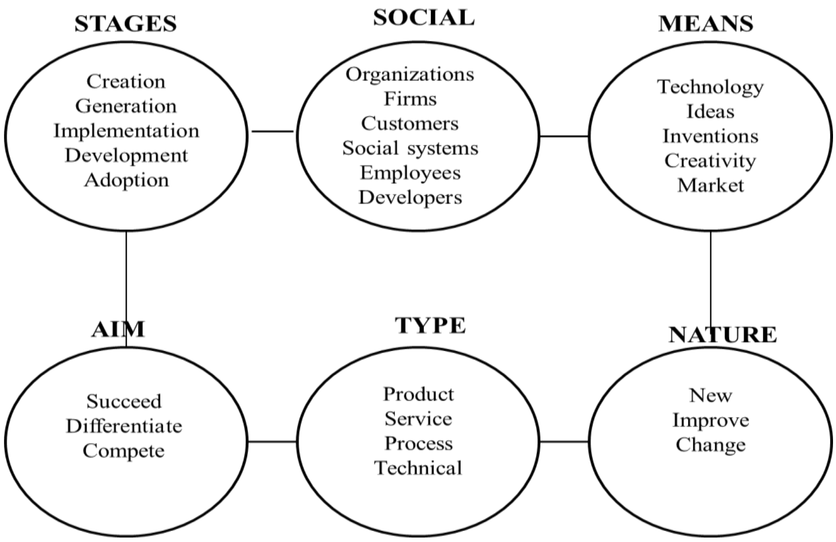
In a careful examination of the literature of innovation, we find the study of Baregheh, Rowley and Sambrrok (2009) who note six basic qualities of the definition of innovation. These have come from the main definitions drawn from dissimilar disciplinary capacities. The "heart" of innovation is presented and explained by these characteristics: stages, social, means, aim, type and nature (Figure 1).

- Stages: denotes the steps taken for the period of innovation process that normally begins from the generation of an idea and ends with commercialization, e.g., creation, generation, implementation, development, adoption.
- Social: states of any social organization, structure or cluster of people that form an integral part of an innovation process or environmental influences in touch

with it. For example: organizations, firms, customers, employees, social systems, developers.

- Means: denotes the assets needed, such as the equipment, ideas, creations, imagination or market that need to be in place for innovation.
- Nature: mentions the form of innovation, such as in something new, improved or changed.
- Type: states the type of innovation, such as in the kind of process, product, service or technology.
- Aim: is the general outcome which the societies want to realize through improvement (e.g., succeed, differentiate or compete).

Figure 1. Focus of innovation definition



Source: Baregheh et al. (2009)

2.1.1.2. Types of innovation

It is necessary to go deeper into the concept of innovation, the most difficult matter being to develop the right definition for it. In addition, we must distinguish whether it is a question of product or process innovation, whether we approach innovation universally or at a specific stage, if we slant it from a technical or managerial perspective, if it is a disruptive –radical– or incremental innovation, etc.

Though the literature has differentiated between numerous typologies of innovation, the most lasting and exploited are the ones covered in Table 2. In this line, it is valuable to make a distinction between: (i) radical innovations –those that make known substantial changes– and incremental innovations –those that only present a small and gradual distinction; (ii) product innovations –the generation and introduction of new products or services within the market– and process innovations –innovations centered upon the growth of novel production processes, new technologies or decision-making styles; and finally (iii) technological innovations –new techniques or techniques that lead to the expansion of new products, services or technologies– and secretarial innovations –innovations more focused on or associated with managerial characteristics.

Table 2. Key typologies of innovation

Criteria	**Typology**	**Literature**
According to the degree of novelty or change that involves	Radical innovation Incremental innovation	Zaltman et al. (1973); Kimberly (1981)
Acccording to the user	Product innovation Process innovation	Zaltman et al. (1973); Damanpour (1991)
According to the scope	Technological innovation Administrative innovation	Daft (1978); Damanpour (1987); Eisenhardt and Martin (2000)

2.1.2. Delimitation of the concept of green innovation performance

2.1.2.1. The green innovation context

Russo and Fousts (1997) had already announced that the environmental management of companies would play an important role in society. But it was with the increase in pollution that public institutions began to worry about environmental issues. Contamination was the actual sign of the ineffective employment of resources (Porter and Van Der Linde, 1995). Nonetheless, until a few years ago the academic society had not paid much consideration to the task of the protection of the environment in the company.

In recent years, with the emerging concern for ecological issues, strict rules and international conventions for the safety of the environment and the rise of environmentalism among customers, firms have had to expand a series of programs associated with the environment. Green issues have grown to become part of the strategic arrangement of organizations as a result of stricter environmental regulations. Therefore, companies must work with their suppliers to share their knowledge and skills to help companies to be more 'green'. This involves an alteration in the attitudes of the companies that want to expand close relations with their providers (Lettice et al., 2010, Chiou, Chan, Lettice and Chung, 2011).

In their effort to carry out environmental proceedings, companies build up new products, process, and/or management innovators that are considered to raise their efficiency and/or efficacy (Gluch, Gustafsson and Thuvander, 2009). This is also how a clear definition of green innovation appears. Chen, Lai and Wen (2006, p. 332) described green innovation performance as "hardware or software innovation that 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".

However, there are four singular expressions used to give details about the type of innovation aimed at minimizing the negative effect that organizations exert upon the environment, such as “eco”, “sustainable”, “environmental”, and “green” (Hashim, Bock & Cooper, 2015), with some differentiations and similarities among them.

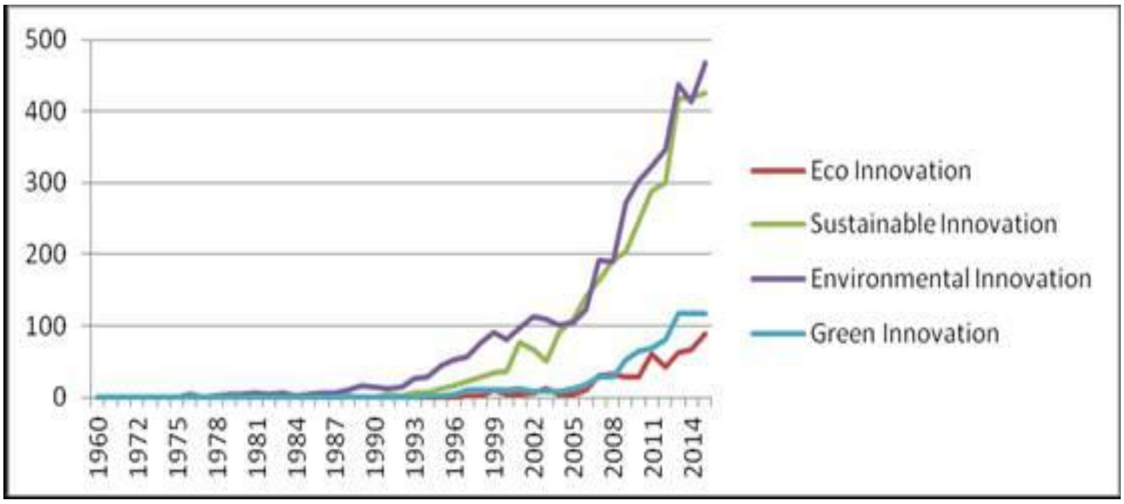
Firstly, we are going to analyze the number of studies published about these four topics from the appearance of the first publication to 2015 through a bibliometric analysis method. The bibliometric analysis in this case examines the bibliographical material of the Scopus database. This is useful for organizing information and identifies the current development and tendencies in a particular field of research (Bouyssou and Marchant, 2011).

Figure 2 shows the number of studies published about these four topics from1960 to 2015. The topic of eco innovation was the first to appear in academic research in 1960. In second place we find the first paper that talked about green innovation. Thirdly, the topic of environmental innovation appears in 1976. And finally, the term sustainable innovation turns up in 1982.

These four terms have evolved significantly in the last years. Nevertheless, they show the existence of three stages in the publication tendency. The first stage corresponds to the period between 1960 and 1990, when the terms first arise. In this first stage, we can find several debates about limits to growth, rising oil prices, etc. Notwithstanding, those works do not define the terms as such, only making certain comments.

The second period covers the time from 1990 to 2005, when research began to grow moderately. Finally, during the third phase, from 2005 to 2015 the volume rose considerably. It is to be noted that, despite environmental innovation and sustainable innovation being the currently predominant terms, from 2005, the notions of eco and green innovation became progressively more used in scholarly publications. However, they are still in their infancy and are considered to be a young field of research (Klewitz and Hansen, 2014).

Figure 2. Number of publications



We briefly assess various of the most accurate definitions in this regard. Fussler and James (1996), the first people to define eco innovation (EO), wrote that it is the development of budding new products, services or processes to make available business and customer value at the same time that significantly decreases the environmental impact. Hemmelskamp (2000) uses the term "eco innovation" to refer to innovation that serves to avoid and/or reduce problems in the environment, diagnose new environmental problems and clean up harm already produced. Kemp and Pearson (2007, p.7) had provided a new definition of eco-innovation that became one of the most referenced definitions. These authors describe eco-innovation as "the production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives". Therefore, eco-innovation consists of new or adapted products, processes, practices and systems which benefit and contribute to green sustainability (Oltra and Saint Jean, 2009). A further definition is given by the Organisation for Economic Co-operation and Development (OECD) (2009), which describes it as the formation or realization of new or superior processes, products, organizational structures, marketing methods and official measures which-with or without intent-lead to environmental improvements associated with appropriate replacements. Recently, the EU-funded Eco-

Innovation Observatory (EIO) defined eco-innovation as a type of innovation which diminishes the use of natural assets and the liberating of harmful substances across the whole life-cycle (EIO, 2013). This broad definition builds on an existing understanding of innovation and highlights types of inputs, outputs and the full cycle impact as indicators of eco-innovation.

The term sustainable or sustainability innovation (SI) has come to be used to refer to a procedure where ecological considerations (environmental, social and economic) are incorporated into a firm's structure from the notion of generation through to research and development (R&D) (Charter and Clark, 2007). The concept of sustainable innovation includes ecological aspects, but also explicitly claims that radically novel or considerably enhanced processes, products or services should contribute to economic and social goals of sustainable development (Wustenhagen et al., 2008). So, this innovation has three proportions: social, economic and environmental.

Brundtland (1987, p. 24) defined sustainable innovation as gathering the requirements of the present without cooperating with the aptitude of potential groups to meet their own needs. The notion does not involve limits or total restrictions, but there are limitations brought about by the current state of technology and social business for ecological resources and by the ability of the environment to take on matters of people's behavior.

Sustainable innovation means innovation that stabilizes the long-term impact of the course and the production on the requirements of the economy, society, people and the situation (Hautamaki, 2010). In line with Church et al. (2008, p.3) it is presented as "the integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and well-being of all people". It also could be defined as an innovation that improves the company's performance where this includes ecological, economic and social criteria (Carrillo-Hermosilla et al., 2010).

This innovation is related with difficulty resolving, the current challenges in society that are mostly complex. For this reason, firms must be one step ahead the others and be able to predict wherever the market will require a viable advance in products and services (HautamÄki and Oksanen, 2016).

Finally, the term environmental innovation (EI) can be defined as innovation focused on decreasing the pessimistic ecological impacts attributable to production techniques (process or product innovation) (Hemmelskamp, 1997). In line with a widespread meaning, this innovation consists of "the production, application or exploitation of a good, service, production process, organizational structure or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use compared to relevant alternatives" (Kemp and Pearson, 2008, p. 7).

This explanation is purposefully wide and includes all the changes in the product portfolio or in the production processes, whether radical or incremental and whether initially intended or not, which tackle sustainability goals, such as waste management, reduction of emissions, recycling, eco-efficiency and eco-design (Rennings, 2000; Markusson, 2010). Besides, environmental innovation consists of a set of new or changed methods, structures, products and processes that serve to prevent or reduce environmental damage (Kemp, et al., 2001). The authors Beise and Rennings (2005) go a step further adding that conservational innovation may be established with or without the clear purpose of reducing ecological harm. Horbach (2008) states that with this innovation it is possible to achieve a "win-win" position: the integration of economic and environmental profits. Next, Table 3 shows the most important definitions of the four topics.

Table 3. Definitions of the four topics

Eco Innovation	
Authors	**Definition**
Fussler and James (1996)	The process of developing new products, processes or services which provide customer and business value but significantly decrease environmental impact
James (1997)	Process for development of new products, processes or services that offer value to clients and businesses with dimishment of environmental impact
Klemmer et al. (1999)	The measures of relevant actors (firms, politicians, unions, churches, private housholds) which develop new ideas, behaviour, products and processes, apply or introduce them and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets
Hemmelskamp (2000)	Innovation which serves to prevent or reduce antropogenic burdens on the environment, clean up damage already caused or diagnose and monitor environmental problems
Rennings (2000)	Innovation processes toward sustainable development
Andersen (2002)	Able to attract green rents on the market
Europa INNOVA (2006)	Creation of novel and competitively priced goods, processes, systems, services and procedures designed to satisfy human needs and provide a better quality of life for all, with a life-cycle minimal use of natural resources per unit output, and a minimal release of toxic substances
Charter and Clarck (2007)	A process where sustainability considerations are integrated into company systems from idea generation through to R&D and commercialization

Kemp and Pearson (2007)	The production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives
European Commission (2008)	The production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its lifecycle, to prevent or substantially reduce environmental risk, pollution and other negative impacts of resource use (including energy)
Oltra and Saint Jean (2009)	Innovations that consists of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability
The Organisation for Economic Co-operation and Development (OECD) (2009)	The creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organisational structures and institutional arrangements which-with or without intent- lead to environmental improvements compared to relevant alternatives
Del Rio et al. (2010)	Innovation that increase the environmental performance of production and consumption activities
Carrillo-Hermosilla et al. (2010)	Innovation that improves environmental performance
Eco-innovation observatory (2013)	The introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle
Sustainable Innovation	
Authors	**Definition**
Brundtland (1987)	It is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. The concept don't imply limits-not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities
Little (2004)	The creation of new market space, products and services or processes driven by social, environmental or sustainability issues
Little (2005)	Creation of new markets spaces, products or services or processes guided by social environmental or sustainability concerns
Fichter (2005)	The development and implementation of a radically new or significantly improved technical, organizational, business-related, institutional or social solution that meets a triple bottom line of economic, environmental and social value creation. Sustainable innovation contributes to production and consumption patterns that secure human activity within the Earths's carrying capacities.
Charter and Clark (2007)	Process where sustainability considerations (environmental, social, financial) are integrated into company systems from idea generation throgh to research and development (R&D) and cmmercialization. This applies to products, services, and technologies, as well as to new business and organizational models
Dresner (2008)	The integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and well-being of all people
Hautamaki (2010)	It means that innovation should balance the long term impact of the innovation aand the actual innovative outcomes, to satisfy the needs of people, societies, the economy and the environment
Haumataki and Oksanen (2016)	Sustainable innovation has is roots in sustainable development, and it is based on ethically, socially, economically and environmentally

	sustainable principles
Environmental Innovation	
Authors	**Definition**
Hemmelskamp (1997)	Innovations focused on reducing the negative environmental impacts caused by the production methods (process or product innovation)
Kemp and Arundel (1998)	New or modified processes, techniques, systems and products to avoid or reduce the environmental impacts
Rennings (2000)	Produce positive spillovers in both the innovation and diffusion phases
VINNOVA (2001)	Innovation that serves to prevent or reduce anthropogenic burdens on the environment, clean up damage already caused or diagnose and monitor environmental problems
Rennings and Zwick (2003)	New or modified processes, equipments, products, techniques and management systems to avoid or reduce the environmental impacts
Beise and Rennings (2005)	It consists of new or modified processes, techniques, practices, systems and products to avoid or reduce environmental harms. Environmental innovations may be developed with or without the explicit aim of reducing environmental harm
Bernauer et al. (2006)	All innovations with a beneficial effect over the environment, regardless of such effect being the main purpose of the innovation; including innovation in processes, products and organizational
Horbach (2008)	New or modified processes, techniques, systems and products that avoid environmental damages. It is possible to achieve a "win-win" situation: integration of economical and environmental benefits
Kemp and Pearson (2008)	The production, application or exploitation of a good, service, production process, organizational structure or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use compared to relevant alternatives
Oltra and Saint Jean (2009)	Consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability
Green Innovation	
Authors	**Definition**
Walley and Whitehead (1994)	Being green is a catalyst for continuous innovation, new market opportunities, and wealth creation
Hart (1995)	Green innovation can help firms improve overall quality of life and be very profitable, not only in terms of efficiency
Porterand van der Linde (1995)	Green innovation can improve corporate image and make companies more successful
Driessen and Hillebrand (2002)	Apply a rather pragmatic definition, stating that it does not have to be developed with the goal of reducing the environmental burden
Noci and Verganti (1999)	Green innovation concerns not only the process but also, and above all, the product (Including the package)
Lai,Wen and Chen (2003)	Green innovation is used to boost the performance of environmental management in order to satisfy the requirement of environmental protection
Chen, Lai and Wen (2006)	Green innovation is defined as hardware or software innovation that 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. Divided the green innovation into: 1) green product innovation and 2) green process innovation
Chen (2008)	Green innovation enables that firms investing many efforts in environmental management can not only avoid the trouble of protests or punishment about environmental protection, but also

	enable them to improve their corporate images, to develop new markets, and to increase their competitive advantages
Chang (2011)	Green innovation can enhance the performance of environmental management to satisfy the requirements of environmental protection. A company devotes to develop green innovation can not only meet the environmental regulations, but also build up the barriers to the other competitors.
Chen, Chang and Wu (2012)	Green innovations can enhance the product value, and thus offset the costs of environmental investments
Tseng, Huang and Chiu (2012)	Green innovation in production requires manufacturers to take actions for planning and managing the work regarding the minimization of environmental impacts related to the innovation function. These typical innovations include typically: 1) management innovation, 2) process innovation, 3) product innovation and 4) technological innovation; and that do not adversely reduce costs and increase productivity
Aguilera-Caracuel and Ortiz-de-Mandojana (2013)	Green innovation incorporates technological improvements that save energy, prevent pollution, or enable waste recycling and can include green product design and corporate environmental management. This type of innovation also contributes to business sustainability because it potentially has a positive effect on a firm's financial, social, and environmental outcomes
Leender and Chandra(2013)	Green innovation broadly as product and process innovation, including the development of new technologies, that focuses on energy saving, pollution prevention, waste recycling and eco-efficient design
Chen, Chang and Lin (2014)	There are two types of green innovation: 1) green radical innovation and 2) green incremental innovation
Hashim, Bock and Cooper (2015)	Green innovation is a type of innovation that has a reduced impact on the environment
Leal-Millan, Roldan, Leal-Rodriguez and Ortega-Gutierrez (2016)	Green innovation is a strategic need for firms, and it offers a great opportunity for meeting buyers' wishes without harming the environment.

The four definitions: i) eco innovation; ii) sustainable innovation; iii) environmental innovation; and iv) green innovation have similarities and differences. The similitudes are quite clear since the four types of innovation are based on trying to improve the environment. However, to know the differences between these definitions is much more complex.

Over the years, several authors have tried to explain this phenomenon. For example, Schiederig et al. (2012, p. 182) recognized six significant aspects in the diverse definitions: (1) innovation object: process, product, service, techniques; (2) market direction: gratify requirements/be competitive on the market; (3) environmental characteristic: decrease negative impact; (4) phase: the full life cycle must be considered (for material flow reduction): (5) desire: the intention to reduce may be economical or ecological; and (6) level: setting a fresh innovation/green standard for the firm. Moreover, we can incorporate two more: (7) social: concerned about the society; (8) technological: expansion of novel technologies to diminish environmental problems.

Table 4 presents the aspects of these definitions to explain the similarities and difference.

Table 4. Aspects of these definitions

	Eco Innovation	Sustainable Innovation	Environmental Innovation	Green Innovation
Innovation object	√	√	√	√
Market orientation	√	√	√	√
Environmental aspect	√	√	√	√
Phase	√	X	√	X
Impulse	√	√	√	√
Level	√	√	√	√
Social	√	X	X	X
Technological	X	X	X	√

One the one hand, when comparing the definitions of sustainable innovation with the notions of eco-innovation, green and environmental innovation, the difference is that the former implements ecological, social and ethical as well as financial aspects, whereas the rest include only ecological and economic characteristics.

On the other hand, many researchers use the terms environmental, green and eco-innovation interchangeably. However, after analyzing the definitions, we can check that they have small nuances. The eco-innovation and environmental innovation definitions analyze the full life cycle with the intention of minimalizing the utilization of natural assets and reducing toxic substances. Then, the two terms are often used interchangeably. In the case of green innovation, this presents a new definition in which the new technologies are present. In a globalized world, technologies play an important role since they help to reduce the environmental impact.

To sum up, the terms are similar but not the same due to the evolution of the definitions over the years having differentiated them. In the beginning, these terms might have seemed synonymous but now they are not used interchangeably. Therefore, it is very important to know which definition will be useful for my study before beginning the research.

For this study, we have chosen the term of green innovation. This decision is based on the consideration of the sector of this study, which is characterized by an innovative and knowledge-intensive industry with a high technological level.

2.1.2.2. Definition of green innovation

We firstly describe the concept of green innovation (GI) as a type of innovation whose key purpose is to reduce the harm, impact and deterioration of the environment, at the same time that it optimizes the use of natural resources while allowing firms to satisfy new consumer demands, create value, increase yields and protect the environment. What is more, green innovation contributes to the creation of key products, services or processes that could provide a sustainable expansion.

Several previous references to the concept have their origin in the literature. Researchers such as Hart (1995) and Porter and Van der Linde (1995) propose that green innovation may raise firms' productivity and maximize their exercise of resources, thus becoming more competitive because of the gain and sustainment of competitive advantages rooted in the corporate image improvement and the development of new markets while satisfying the requirement of environmental protection (Lai et al., 2003, Chang, 2011). Nevertheless, it is after the publication of a seminal article on green innovation by Chen, Lai and Wen (2006) that a growing flow of research was generated with regard to this particular topic. This is the first time that a clear concept of green innovation appears.

Chen et al. (2006, p. 332) define "green innovation" as "hardware or software innovation that 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". In their efforts to carry out environmental actions, companies might develop new products, processes, and/or managerial innovations that are designed to boost their levels of efficiency and/or effectiveness (Gluch et al., 2009). These authors also suggest that green innovation is involved in waste recycling, green product designs, energy saving, pollution prevention, and corporate environmental management.

For Chang (2011, p. 363), the term green innovation "can enhance the performance of environmental management to satisfy the requirements of environmental protection. A company devotes to develop green innovation cannot only meet the environmental regulations, but also build up the barriers to the other competitors". Leenders and Chandra (2013) argue that green innovation is a product or process innovation that includes the development of new technologies focused on pollution prevention, waste recycling, energy saving, and eco-efficient design.

The conceptualization has continued evolving to more recent definitions such as the ones provided by Aguilera-Caracuel and Ortiz-de-Mandojana (2013, p. 365) –

"Green innovation incorporates technological improvements that save energy, prevent pollution, or enable waste recycling and can include green product design and corporate environmental management. This type of innovation also contributes to business sustainability because it has a potentially positive effect on a firm's financial, social, and environmental outcomes"; Hashim et al., (2015), who posited that this kind of innovation seeks to reduce the impact of the firm's activity on the environment by including transformations in corporate strategies, product-designing methods, production processes, resource consumption, and waste disposal procedures; Albort-Morant et al. (2016), where green innovation is posited to comprise a critical way to mitigate or avoid environmental damage while exerting a responsible and optimal use of the available resources; and Leal-Millán et al., (2016, p. 448) –"Green innovation is a strategic need for firms, and it offers a great opportunity for meeting buyers' wishes without harming the environment". Accordingly, the conceptualization of green innovation has moved from more resource-oriented definitions to a more comprehensive framework that includes the firm's compliance with the stakeholders' green requirements and demands.

For that reason, green innovation has continued to exert a positive effect on competitive advantage (Porter and Van der Linde, 1995; Klassen and Whybank, 1999; Chen, et al., 2006). If companies are ready to carry out green innovations, they might capture the advantages of differentiation and challenge the existing competitive rules. Green innovation has become a core strategic concern for firms, which may be described as a combination of abilities and knowledge that enables the generating of commercial innovations without harming the environment (Leal-Millán et al., 2016).

Hence, the companies would commercialize sustainable products—protection of the environment in the design and packaging of products—that might heighten the differentiation advantages (Chen et al., 2006; Hart, 1995). We define the term of green innovation "is posited to comprise a critical way to mitigate or avoid environmental damage while exert a responsible and optimal use of the available resources" (Albort-Morant, Leal-Millán and Cepeda Carrión, 2016, p. 4913).

Moreover, the implementation of environment-oriented managerial proactive strategies will permit companies to avoid facing sanctions or environmentalists' protests (Henriques and Sadorsky, 1999). The pioneers in putting into practice green innovation can sell green products and services at higher prices, enjoying higher profits, selling their innovative environmental technologies, developing their corporate image, and even producing novel markets (Peattie, 1992; Porter and Van der Linde, 1995) that address the needs of the most demanding customers. In this way, green innovation augments the companies' productivity and efficiency at assigning resources and their ecological management performance in order to meet the requirements of ecological safety (Lai et al., 2003), at the same time as creating while generating a competitive advantage over competitors (Barney, 1991). Below, Table 5 shows the definitions of the topic green innovation.

Table 5. Definitions of Green Innnovation

Author	Definition
Walley and Whitehead (1994, p. 81)	Being green is a catalyst for continuous innovation, new market opportunities, and wealth creation
Hart (1995, p. 987)	Green innovation can help firms improve the overall quality of life and be very profitable, not only in terms of efficiency
Porter and van der Linde (1995, p. 121)	Green innovation can improve corporate image and make companies more successful
Driessen and Hillebrand (2002, p. 344)	Apply a rather pragmatic definition, stating that it does not have to be developed with the goal of reducing the environmental burden
Noci and Verganti (1999, p. 10)	Green innovation concerns not only the process but also, and above all, the product (including the packaging)
Lai, Wen and Chen (2003)	Green innovation is used to boost the performance of environmental management in order to satisfy the requirement of environmental protection
Chen, Lai and Wen (2006, p. 332)	Green innovation is defined as hardware or software innovation that 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. Divided the green innovation into: 1) green product innovation and 2) green process innovation
Chen (2008, p. 273)	Green innovation enables firms to invest a great effort in environmental management—avoiding the trouble of protests or punishment about environmental protection—to improve their corporate images, to develop new markets, and to increase their competitive advantages
Chang (2011, p. 363)	Green innovation can enhance the performance of environmental management to satisfy the requirements of environmental protection. A company devoted to developing green innovation can not only meet the environmental regulations, but also build up the barriers to the other competitors.
Chen, Chang and Wu (2012, p. 369)	Green innovations can enhance product value and thus offset the costs of environmental investments
Tseng, Huang and Chiu (2012, p. 247)	Green innovation in production requires manufacturers to take actions for planning and managing the work regarding the minimization of environmental impacts related to the innovation function. These typical innovations usually include: 1) management innovation, 2) process innovation, 3) product innovation and 4) technological innovation; which do not adversely reduce costs and increase productivity
Aguilera-Caracuel and Ortiz-de-Mandojana (2013, p. 365)	Green innovation incorporates technological improvements that save energy, prevent pollution, or enable waste recycling and can include green product design and corporate environmental management. This type of innovation also contributes to business sustainability because it has a potentially positive effect on a firm's financial, social, and environmental outcomes
Leender and Chandra (2013, p. 204)	Green innovation broadly as product and process innovation, including the development of new technologies, that focuses on energy saving, pollution prevention, waste recycling and eco-efficient design
Chen, Chang and Lin (2014, p. 7789)	There are two types of green innovation: 1) green radical innovation and 2) green incremental innovation

Hashim , Bock and Cooper (2015, p. 1017)	Green innovation is a type of innovation that has a reduced impact on the environment
Leal-Millán, Roldan, Leal-Rodríguez and Ortega-Gutiérrez (2016, p. 448)	Green innovation is a strategic need for firms, and it offers a great opportunity for meeting buyers' wishes without harming the environment.
Albort-Morant, Leal-Millán and Cepeda Carrión (2016, 4913)	Green innovation is posited to comprise a critical way to mitigate or avoid environmental damage while exerting a responsible and optimal use of the available resources

2.1.2.3. Types of green innovation

In an effort to effectively disentangle the true life of green innovation, some authors suggest the need to distinguish between a number of typologies of green innovation. Authors such as Porter and Van der Linde (1995), Klassen and Whybank (1999), Chen et al. (2006), and Chang (2011) separate green innovation into green product innovation and green process innovation. These authors give details of the process of innovation as a course that adapts the design of an accessible product that enables reducing the negative impact on the environment. This means adapting the company's production process for the period of process of acquirement, alteration (production) and liberation of the company's products.

Besides, the authors Chen et al. (2006) and Chen (2008) incorporated additional typologies such as green managerial innovation -the firm's endeavor to incorporate green practices and purposes into their corporate strategy. Consequently, the authors recommend three domains for green innovation: i) green product innovation, ii) green process innovation, and iii) green managerial innovation. Later, green innovation was classified into four categories: i) green product innovation—the introduction of new products and services characterized by waste recycling, pollution-prevention or energy-saving; ii) green process innovation—the development of production that is connected to satisfying the requirements of environmental protection; iii) green managerial innovation—the company's aptitude to devise green projects with suitable programming that allows re-designing and improving the products or services so that a higher compliance with the environmental criteria is observed; and iv) green technological innovation—new green tools and sophisticated green production technology that lead to the progress of green products and services (Tseng, Huang, and Chiu, 2012; Tseng et al., 2013).

A second taxonomy distinguishes between reactive and proactive green innovation. In this vein, Chen et al. (2012) describe reactive green innovation as the actions that occur passively to observe environmental values or rules, to adjust to the requirements of stakeholders or to respond to the challenges of the competition, and proactive green innovation as those proactive innovations whose practices or products are advanced compared to the competitors' and enable the leveraging of the opportunities that appear on the market or the acquiring of competitive advantages (O'Connor et al., 2008).

In addition, the study developed by Chen et al. (2014) suggests the need to distinguish between green radical innovation—the essential or revolutionary changes in existing green products, processes or services by means of environmental technology that reinforces, adjusts, or encompasses current environmental knowledge—and green incremental innovation—the irrelevant progresses or simple modifications in existing green products, services or processes by means of environmental technology that reinforces, adapts, or extends present environmental knowledge (Subramaniam and Youndt, 2005). Table 6 presents a summary of the main green innovation taxonomies- including dimensions and authors- and Table 7 shows the measures of the four types of green innovation that appear in key studies.

Table 6. Main green innovation taxonomies

Author	**Taxonomy**
Klassen and Whybank (1999); Porter and Van der Linde (1995); Hart (1995); Chen, Lai and Wen (2006); Chang (2011)	Distinction between *green product innovation* and *green process innovation*
Chen et al. (2006); Chen (2008); (Tseng, et al., 2013)	Distinction between *green product innovation*, *green process innovation*, *green managerial innovation* and *green technological innovation*
O'Connor et al. (2008) Chen et al. (2012)	Distinction between *green reactive innovation* and *green proactive innovation*
Chen, Chang and Lin (2014)	Distinction between *green radical innovation* and *green incremental innovation*

Table 7. Measures of types of innovations

Types of Green Innovation	**Measures**	**References**
Green Product Innovation	1) Degree of new green product competitiveness understand customer needs 2) Evaluation of technical, economic and commercial feasibility of green products 3) Recovery of company's end-of-life products and recycling 4) Use of eco-labeling, environment management system and ISO 14000	Utterback and Abernathy (1975); Noci and Verganti (1999); Chen et al. (2006); Yung et al. (2011); Tseng et al. (2012)

	5) Innovation of green products and design measures	
Green Process Innovation	1) Low energy consumption such as water, electricity, gas and petrol during production/ use/disposal 2) Recycling, reuse and remanufacture material 3) Use of cleaner technology to make savings and prevent pollution (such as energy, water and waste) 4) In-house audit to appraise environmental performance of supplier 5) Process design and innovation and enhances R&D functions 6) Low cost green provider: unit cost versus competitors' unit cost	Utterback and Abernathy (1975); Athaide et al. (1996); Rao and Holt (2005); Chen et al. (2006); Tseng et al.(2009); Tseng et al. (2012)
Green Management Innovation	1) Redefinition of operation and production processes to ensure internal efficiency that can help to implement green supply chain management 2) Re-design and improvement of product or service to obtain new environmental criteria or directives 3) Reduction of hazardous waste, emission, etc 4) Less consumption of e.g., water, electricity, gas and petrol 5) Install environmental management system and ISO 14000 series 6) Providing environmental awareness seminars and training for stakeholders	Chen (2008); Tseng (2010); Lin et al. (2011); Tseng et al. (2012)
Green Technological Innovation	1) Investment in green equipment and technology 2) Implementation of comprehensive material saving plan 3) Supervision system and technology transfer 4) Advanced green production technology 5) Management of documentation and information	Rao (2002); Rao and Holt (2005); Qi et al. (2005); Zhu et al. (2008); Tseng et al. (2012)

2.1.2.4. Green innovation and knowledge management

The term of Green innovation can be enclosed within the knowledge-based view (KBV). Originally, the resource-based view (RBV) of the company (Barney, 1991) thoroughly follows the firms' diversity in terms of their varied resource configuration and its implication while attaining and supporting competitive advantages. Subsequently Nonaka (1991) remarks that both firms and persons are currently absorbed in a deep knowledge spiral. In this line, this author contends that "in an economy where the only certainty is uncertainty, the only sure source of sustainable competitive advantage is knowledge" (Nonaka, 1991, p. 96). It appears that, if not the most dynamic resource, knowledge these days establishes a strategic resource for numerous firms and a simple foundation of competitive advantage.

Therefore, it is commonly sustained that a firm's KBV is rooted in the RBV. From such a point of view, knowledge is supposed to be the very essence of corporate strategy, being a well thought-out and important strategic resource. The strategic significance of knowledge develops from its effort to be transferred, replicated or assumed that hence makes it work as a foundation for producing sustainable competitive advantages (Teece, Pisano, and Shuen, 1997).

The crucial foundations confirming the KBV are the following: (i) knowledge is supposed to be the organization's core strategical resource, as it denotes a sustainable source of competitive advantage; (ii) there are varied knowledge typologies (i.e., tacit–explicit), which comprise in turn different spreading and dissemination methods; and (iii) individuals are mainly responsible for the knowledge-creation process, especially for tacit knowledge (Grant, 1996). Then, following Barney (1991), knowledge complies with all the requirements to become a source of sustainable competitive advantage (i.e., being rare, appreciated, difficult to copy and inimitable).

Furthermore, there is a positive connection between knowledge management and green innovation (Chen and Huang, 2009). So, the management literature has profoundly suggested that a vital precondition for the growth of innovations is to obtain, integrate, change and exploit information for it to become organizational knowledge (Leal-Rodríguez, et al., 2014). Such a learning-related organizational capability is characterized as absorptive capacity (Zahra and George, 2002). As a result, knowledge has been typically recommended as a core resource to maintain innovativeness and green innovation.

In addition, in the knowledge-based era, knowledge is observed to be a critical advantage and influential strategic driver, which is constantly generated by means of individuals' collaboration and knowledge-sharing mechanisms (Grant, 1996). Nonetheless, the course of knowledge design is not limited to the firm's internal borders, but is often built through networks and cooperation links with stakeholders (i.e., customers, suppliers, partners and even competitors). Accordingly, the knowledge base following effective supply chain networking becomes vital for improving green innovation. The firms' capability to shape a profound and extensive knowledge base through combining external and internal knowledge sources is crucial for supporting innovative processes and for developing green products and services (Leal-Millán, et al., 2017), and as a consequence creating higher value for stakeholders (Martelo-Landroguez and Cegarra-Navarro, 2014).

When companies share relevant information and knowledge with their stakeholders by means of supply chain networking instruments, they mutually enrich their knowledge bases, organizational capabilities, and performance through relationship-level learning. Several works in the literature recognize the need to efficiently manage supply chain relations and alliances as strategic matters, while making an effort to increase business results and capabilities, such as green innovation (Azzone and Noci, 1998; Chen et al., 2006; Zacharía et al., 2011; Chiou et al., 2011). This background will be operationalized by the 'co-production' and 'ad hoc green innovation' theses.

2.2. Theoretical foundations of Knowledge Base

2.2.1. Delimitation of the concept of knowledge management

With the intention of locating ourselves applicably within the framework of knowledge management (KM), it seems to be necessary to delimit the concept of knowledge to differentiate what can be considered knowledge from what cannot. Delving into a knowledge-based theory implies facing the question of "what is knowledge?" (Grant, 1996).

The concept of knowledge is extensive and complex since a variety of definitions and ways to bring it out exist. Nevertheless, many definitions are in accordance with those which are fundamental. Knowledge can be defined in an extensive and simple sense as "everything that is known" (Grant, 1996). Schulz (2001) defines it in turn as everything that has been knowledgeable through practice or study. According to Nonaka and Takeuchi (1995), there is the vital role played by skills in knowledge process learning. In this vein, Davenport and Prusak (1998) describe knowledge as a box of values, contextual information experiences, and expert insight, which offers a background for measuring and including new experiences and information.

Having assumed that knowledge is a valuable resource for the firm – both at the individual and organizational levels – the second question that we must ask ourselves and/or the question that managers should reflect upon is: "how should we manage what we know?".

The knowledge absorptive capacity can lead firms to better their outcomes and disseminate competitive advantages, but it does not essentially denote this triumph if this asset is not effectively managed. For example, if it penetrates into the core of companies, the presence of information and knowledge flows –both formal and informal– can easily be identified. Nonetheless, this knowledge is not always efficiently diffused. It is largely what knowledge management (KM) tries to resolve. For this reason, the purpose of KM is to transfer knowledge from the place where it is generated to the place where it will be used. To do this, KM involves the development of the necessary competencies to share and use it among members of organization.

In that way, KM is transformed into an important area of interest within the collected managerial work. The literature makes plenty of definitions for KM available and there is an absence of agreement about its rigorous connotation. Nonetheless, many of these conceptualizations approach KM by way of a varied set of key methods, techniques and procedures which are valuable for effectively managing knowledge within organizations.

Table 8 presents a set of definitions that approach KM in a similar perspective.

Table 8. Main definitions of Knowledge Management

Authors	Definition
Nonaka and Takeuchi (1995)	The process of explicitly working with the firm’s intangible assets –knowledge– producing, searching, storing and transmitting knowledge with the objective of enhancing the firm’s performance and productivity.
Wiig (1997)	A set of practices oriented to efficiently understanding, concentrating and managing the knowledge creation, renewal and application in a systematic, explicit and intentioned way.
Van der Spek and Spijkervet (1997)	The explicit management and control of knowledge inside organizations with the purpose of accomplishing the firm’s goals and objectives.
Liebowitz and Wilcox (1997)	The firm’s capability of managing, loading, valuing and distributing knowledge.
O’Leary (1998)	The firm’s formal management of knowledge with the aim of enabling the creation, access, and reutilization of knowledge generally through the use of advanced technologies.
Davenport and Prusak (1998)	A set of processes oriented to capturing, distributing, and effectively using knowledge within organizations.
Teece (2000)	A set of procedures and techniques used to obtain the most from a firm's knowledge assets.
Jashapara (2004)	The effective processes linked with exploration, exploitation and distribution of human knowledge using the appropriate technology and cultural environments to enhance the firm’s intellectual capital and performance.

We can be perceived, most of the definitions included in the table 8 are essentially dogmatic. Hence, authors think that, through knowledge as a main resource, organizations should manage well with the intention of being able to better results and improve performance.

2.2.2. The knowledge-based view of the firm

During the 1990s, a variety of research streams and a number of new ideas, such as the analysis of the company's resources/capabilities produced what has come to be defined as "the knowledge-based view or the knowledge-based theory" (KBV) (Barney, 1986, 1991; Grant, 1991). The main principle of KBV is that a firm has the ability to manage, maintain, and create knowledge, since knowledge is considered to be an essential strategic resource to generate new value creation and competitive advantages (Grant, 1996; Teece et al., 1997; Fernández, 2003).

However, the KBV view has three vital principles which support this view: (i) well thought-out knowledge is the firm's main strategically resource, as it establishes a sustainable source of competitive advantage; (ii) diverse types of knowledge (i.e., tacit vs. explicit, personal vs. organizational, internal vs. external, procedural vs. declarative, etc.); and (iii) persons are mainly responsible for knowledge-creation, especially for tacit knowledge (Grant, 1996).

Noting knowledge as the key resource can be acceptable on the basis of the opinions delivered by the resource-based view, that suggests that with the intention of being strategically relevant and therefore becoming a source of sustainable competitive advantages, resources must meet four requirements: be rare, valuable, difficult to imitate and not replaceable (Barney, 1991).

At the same time, the knowledge-based view has been multiplying numerous currents and research lines that are categorized by dividing their attention on knowledge. Among them there can be found theories and topics such as the core competence of the corporation (Prahalad and Hamel, 1990), dynamic capabilities (Teece et al., 1997) and knowledge management (Nonaka, 1994; Nonaka and Takeuchi, 1995).

Recently, the contributions to this literature tend to emphasize how a firm's knowledge base represents its most unique resource for radical innovation development (e.g., Subramanian and Youndt, 2005; Miller, Fern and Cardinal, 2007; Zhou and Wu, 2010) or how organizational knowledge adapts to the market's technological and environmental needs (e.g., Kearns and Sabherwal, 2006; Leal-Millán et al., 2017).

2.2.3. Organizational knowledge base

According to the knowledge-based theory, knowledge is the most significant strategic resource, since the service rendered by tangible resources is certain of an approach which unites them and is applied. This is consequently a purpose of the company's knowledge and abilities (Grant, 1996; Van de Hooff and Ridder, 2004).

Davenport and Prusak (1998, p. 5) defined knowledge as "a flux mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms". The knowledge base sets up its possibility and ability to understand and make use of new knowledge for decision-making, innovations or difficulty solving (Ahuja and Katila, 2001).

Zhou and Wu (2010) affirm that the existing knowledge base of an organization, namely its knowledge depth and breadth, signifies its foremost resource for innovation development. Knowledge depth and breadth are two dimensions of a knowledge base that show both the structure and the content of the knowledge a firm has. The former refers to the vertical dimension of knowledge and heterogeneous knowledge content, wherein this attribute reflects a vertical dimension and unique, complex, within-field knowledge content (Luca and Atuahene-Gima, 2007; Zhou and Li, 2012). In-depth knowledge in a specific industrial field is essential for innovation because it facilitates the effective realization of substantial information as new ideas (Katz and Du Preez, 2008). The latter captures the horizontal dimension that refers to the degree of indicating the level of sophistication and complexity of knowledge in key fields (Bierly and Chakrabarti, 1996). A broad knowledge base with varied, accumulated observations and cues facilitates an understanding of new information and potential changes to detect market opportunities for its radical innovation (Chesbrough, 2003).

Accordingly, a firm's knowledge base can be deep if it has accumulated thorough experience and know-how about many fields (e.g., in the sector of the automotive components, if a company has information on many pieces of vehicles), or it can be broad when companies are specialized in any field (for instance, a company which is specialized in windows for vehicles has the skills that are required to efficiently produce a new design.

Nevertheless, the management literature has evidently acknowledged that knowledge can also be categorized into some types of firm-relevant knowledge. We show the main types of a company's knowledge-base (see the table below).

Knowledge can be internal or external depending on the source of the information. Internal knowledge has its place in the organization that is necessary for its purpose. Yet companies need to mature external connections to access knowledge from their industry, market, competitors, customers or suppliers that will facilitate the creation of new knowledge adapted to new needs. The skill to associate internal and external knowledge is essential for supporting product, service and process innovations ((Laursen and Salter, 2006, Zhou and Li, 2012). In the same way, the knowledge can be individual when it comes from a person or organizational when it is within an organization. Both individual and organizational knowledge have the ability to add new knowledge to existing knowledge.

The distinction between complex and simple innovations depends on numerous managerial theorists but various definitions of innovation difficulty are broadly specified or unclear (Gopalakrishnan and Damanpour, 1994). On the one hand, an innovation can be complex if it is associated with knowledge that is sophisticated and difficult to understand. On the other hand, simple knowledge is easy and quick to assimilate and understand.

Explicit knowledge can be communicated and simple to transfer while tacit knowledge is rigid to articulate and particularly uncertain to transfer because it depends on personal experience. Therefore, tacit knowledge is revealed through its application. Tacit knowledge is hard to copy, imitate or reproduce, and the process of accruing and applying knowledge is more likely to create new sources of competitive advantage which are more sustainable over time (Grant and Baden-Fuller, 2004).

Chesbrough and Teece (1996) defined autonomous innovations as those that can be developed and implemented independently from other innovations and organizational processes. Systematic innovations can be implemented only in conjunction with related, complementary innovations. In this line, autonomous knowledge is the knowledge that can be learned and be implemented independently and systematically, and can only be applied in combination with other complementary skills.

Table 9 encompasses the distinct types of knowledge that may be treasured by organizations.

Table 9. Types of knowledge within an organization

14 types of knowledge within an organization				
Internal	Internal knowledge of the organization without which it would be impossible for it to operate		**External**	Knowledge acquired from outside already belongs to suppliers, customers, the competition, the government, the industry, etc.
Individual	Knowledge that a person possesses		**Organizational**	Knowledge that an organization possesses
Complex	Knowledge is difficult to understand and use		**Simple**	Knowledge easy to assimilate
Breadth	Extensive knowledge about a variety of disciplines	**Vs**	**Depth**	Deep knowledge of a discipline
Tacit	Personal knowledge based on experience. Difficult to transmit		**Explicit**	Knowledge directly codifiable. It is directly accessible to all members of the organization
Systemic	Knowledge that can be applied only in combination with other complementary skills		**Autonomous**	Knowledge that can be independently learned and implemented

2.3. Theoretical foundations of Absorptive capacity

2.3.1. Delimitation of the concept of absorptive capacity

Cohen and Levinthal (1990) were apparently the first authors to use the term absorptive capacity (ACAP). These authors defined it as “the ability of recognizing new external knowledge, assimilating and applying it to commercial ends” (p. 128). This term was introduced to explicate that some firms are in a better position to take advantage of accessible external knowledge than others in the sector (McDonald and Madhavaram, 2007).

Developing and keeping this critical capability is very important for a company’s long-term survival and success, since such an ACAP can strengthen, supplement or reorient the previous and related knowledge base which the firm already possesses.

There are several studies which, on the basis of Cohen and Levinthal’s (1990) delimitation of ACAP have provided their own definition. Below there are several of the most significant works which enhance the denotation and improve the conceptualization of this term.

In a first approximation toward the concept of absorptive capacity, Mowery and Oxley (1995) describe it as a broad set of abilities that are needed to deal with the tacit components of the transferred technology, as well as the frequent necessity of modifying external sources of technology. As can be perceived, this term is focused on the absorption of technology-based knowledge.

Kim (1998) posits that absorptive capacity deals with the capacity to learn and solve problems. This author compares ACAP with the skill to acquire and resolve trouble.

According to Lane and Lubatkin (1998), absorptive capacity involves a firm's ability to evaluate, assimilate and apply a new piece of knowledge presented by another firm. These authors make a very fascinating contribution, as they vary the analysis unit, passing from the firm level to the master-pupil pair, in which the capability of one firm to learn from another is determined by the features of both the firm that learns –pupil– and the firm that teaches –master. This increases the so-called relative absorptive capacity.

The most widely accepted and followed mode of absorptive capacity is that of Zahra and George (2002). For these authors, absorptive capacity is as a dynamic set of routines and organizational processes through which companies acquire, assimilate, transform and exploit knowledge. Moreover, they divide absorptive capacity into two stages, dimensions or different time periods: (i) potential absorptive capacity (PACAP) and (ii) realized absorptive capacity (RACAP). PACAP includes the firm's ability to obtain and integrate knowledge. That is, the strength with which this firm carries out the purpose of recognizing and obtaining novel knowledge from outside the company, and then integrating it internally. RACAP, on the other hand, is narrowed down to the change and utilization of knowledge by the organization. Knowledge transformation and exploitation include extracting new points of view, reasoning and conclusions from the combination of the firm's existing knowledge and that which has been recently assimilated, and its application to the firm's operations.

In a later work of Lane, Koka and Pathak (2006), they define ACAP as the firm's ability to take advantage of the externally obtained knowledge by means of three sequential processes: (i) identifying and recognizing the value of the new external knowledge, (ii) assimilating the valuable new knowledge, and (iii) applying the assimilated knowledge in order to create new knowledge and obtain commercial outcomes. This is aided by means of three types of learning, which are exploratory, transformative and exploitative learning, respectively.

On the other hand, Todorova and Durisin (2007) define ACAP as the firms' ability to distinguish the value of external knowledge, and to further acquire, assimilate and exploit it. These authors hence combine the studies of Cohen and Levinthal (1990) and Zahra and George (2002). Todorova and Durisin (2007) assume the new idea ofCohen and Levinthal (1990) suggest that the ACAP process should begin by identifying and recognizing valuable external knowledge. They further question Zahra and George's (2002) model in terms of the extent to which assimilation and change are stages which follow each other, considering instead that they are sometimes complementary phases.

Cepeda-Carrión et al. (2012) link the concepts of absorptive capacity and firm innovativeness in a more direct manner. For these authors, ACAP is the quality that enables the conversion of knowledge into new products, services or processes, supporting, therefore, the innovation.

Leal-Rodriguez et al. (2014) have provided a new definition of ACAP as the ability that allows the acquisition of recently created knowledge, and its internal assimilation and combination with the firm's prior related knowledge in order to learn, generating new knowledge and applying it to the firm's innovation process.

In the following table we collect some of the main definitions of authors that make reference to processes of absorption capacity, from the more initial descriptions proposed by Cohen and Levinthal (1989) to more recent developments.

Table 10. Definitions of absorptive capacity

Authors	**Definition**
Cohen and Levinthal (1989)	Absorptive capacity is the capacity to learn external knowledge through the processes of its identification, assimilation and exploitation
Cohen and Levinthal (1990)	Absorptive capacity is the ability to assimilate and apply new external knowledge to commercial ends
Mowery and Oxley (1995)	Absorptive capacity involves a broad set of abilities that are needed to deal with the tacit components of the transferred technology, as well as the frequent necessity of modifying external sources of technology
Kim (1998)	Absorptive capacity deals with the capacity to learn and solve problems
Lane and Lubatkin (1998)	Absorptive capacity involves a firm's ability to evaluate, assimilate and apply a new piece of knowledge offered by another firm
Zahra and George (2002)	Absorptive capacity is a dynamic set of routines and organizational processes through which companies acquire, assimilate, transform and exploit knowledge
Lane et al. (2006)	Absorptive capacity deals with the firm's ability to take advantage of the externally obtained knowledge by means of exploratory, transformation and exploitative learning
Todorova and Durisin (2007)	Absorptive capacity is the firm's ability to recognize the value of external knowledge, and of further acquiring, assimilating and exploiting it
Lichtenthaler and Lichtenthaler (2009)	Absorptive capacity as the ability to find new ideas and incorporate them into organizational processes

Cepeda-Carrión et al. (2012)	Absorptive capacity is the quality that enables the conversion of knowledge into new products, services or processes, hence supporting innovation
Leal-Rodríguez et al. (2014)	Absorptive capacity is the ability that enables the acquisition of recently generated knowledge, and its internal assimilation and combination with the firm's prior related knowledge, in order to learn, create new knowledge and apply it to the firm's innovation process

2.3.2. Research models of absorptive capacity

Having reviewed the main definitions of ACAP in the literature, we highlight that many authors have focused on ACAP by generating different research models. The most relevant are: (i) the model of Cohen and Levinthal (1990), (ii) the model of Lane, Salk and Lyles (2001), (iii) the model of Zahra and George (2002), (iv) the model of Jansen, Van den Bosch and Volberda (2003), (v) the model od Lane, Koka and Pathak (2006), (v) the model of Todorova and Durisin (2007).

- The model of Cohen and Levinthal (1990)

Cohen and Levinthal (1990) were the first to introduce the concept of ACAP. The model proposed by the authors depends on the sources of external knowledge and the quality of accumulated knowledge. In this model, ACAP covers 3 sequential dimensions: recognition, assimilation and application of knowledge. ACAP was proposed as an antecedent of the companies' innovative activity.

- The model of Lane, Salk and Lyles (2001)

This model appreciates ACAP in the context of international joint ventures (IJV). It divides ACAP according to the three dimensions of the model offered by Cohen and Levinthal (1990) -recognition, assimilation and application. The recognition and assimilation of knowledge contributes to the improvement of the company's knowledge related to organizational performance. This aspect is associated with the term of absorptive capacity established by Zahra and George (2002).

- The model of Zahra and George (2002)

These authors defined ACAP as a dynamic set of routines and organizational processes through which companies acquire, assimilate, transform and exploit knowledge. Moreover, these authors hypothesize ACAP as an antecedent of the firm's competitive advantage, strategic flexibility, innovation and performance.

These authors also propose the existence of two subunits which are different but complementary to ACAP: on the one hand, the potential of absorptive capacity (PACAP), which is composed of two dimensions - acquisition and assimilation of knowledge - and, on the other hand, realized absorptive capacity (RACAP), which involves the dimensions of transformation and exploitation of knowledge.

- The model of Jansen, Van den Bosch and Volberda (2003).

These authors develop a new model based on the previous model of Van den Bosch et al. (1999) and include some improvements proposed by Zahra and George (2002). In this model, there are three different capacities - coordination, systems and socialization - which are a history of ACAP. On the other hand, ACAP is modeled as a history of the adaptation and the performance of enterprises. The model also contemplates the two subunits of ACAP –PACAP and RACAP- proposed by Zahra and George (2002).

- The model of Lane, Koka and Pathak (2006)

The model suggested by Lane et al. (2006) involves four different components. The essential part involves the firm's ACAP. In this model, ACAP is well defined by means of a successive process which perceives three different mechanisms that coincide with the three dimensions of ACAP postulated by Cohen and Levinthal (1990): identifying and accepting new external knowledge – by means of exploratory learning-, assimilating the valuable external knowledge – through transformation learning- and applying the assimilated external knowledge- by virtue of exploitative learning.

On the left of the model there can be observed the partially or totally external antecedents of ACAP –features of internal and external knowledge, environmental conditions and the characteristics of learning relationships. Above and below the ACAP section of the model there are the internal precursors of ACAP- characteristics of the mental models of the firm's members, as well as the firm's approaches, structures and processes. To finish, on the right side of the model there can be found the outcomes of ACAP- knowledge outputs, firm performance and commercial yields.

- The model of Todorova and Durisin (2007)

Todorova and Durisin (2007) complement the model introduced by Zahra and George (2002), offering some progress. First of all, their model contains the appreciation of valuable knowledge- the first dimension of ACAP proposed by Cohen and Levinthal (1990)- as an antecedent to the four dimensions that process ACAP in Zahra and George's (2002) model. Secondly, it treats the knowledge assimilation and transformation dimensions as replacements instead of being consecutive, depending on if the acquired external knowledge is very comparable to the firm's associated knowledge or not, correspondingly.

This model posits the firm's knowledge basis and previous related knowledge as antecedents of ACAP. On the other hand, the following outcomes of ACAP - competitive advantage attainment and the firm's flexibility, innovativeness and performance- are hypothesized.

This model means to be an improvement to the proposal of Zahra and George (2002). Both models view ACAP as an intermediate variable which gives place to interesting outcomes. However, both models are exclusively theoretically established and neither of them attempts to empirically test their hypotheses.

2.4. Theoretical foundations of Dynamic Capabilities

2.4.1. Organizational capabilities: ordinary and dynamic

Many strategy scholars have tried to understand why numerous companies are more successful than others in capacities in a dynamic environment. Firstly, Zollo and Winter (2002) and Winter (2003) suggest the need to distinguish between the types of capacities, processes and/or routines existing in companies. These authors differentiate between two important classes of capability: the first ordinary – operational routines (zero-order) - and the other involving the modification of operating routines' dynamic capabilities (first-order). A capability is defined as a high-level routine (or a collection of routines) and a routine is a "behavior that is learned, highly patterned, repetitious, or quasi-repetitious, founded in part in tacit knowledge-and the specificity of objectives" (Winter, 2003, p. 991).

Dynamic and ordinary capabilities change in their determinations and intended outcomes (Helfat and Winter, 2011). Ordinary capabilities comprise the firm’s operational functioning, being also labeled "how we earn a living now" capabilities (Cepeda and Vera, 2007). The zero-order or ordinary capabilities are geared on the firm’s operational functioning, including both line activities and staff. These are “how we earn a living now” capabilities. The resource-based view (RBV) of the company proposes that ordinary capabilities are principally significant since internal resources and capabilities are the basis of a firm’s strategy. They are the primary source of profit and offer a stable basis for describing a firm’s identify (Colotta, Shi and Gregory, 2003). According to Wu, Melnyk and Flynn (2010), ordinary capabilities “are firm-specific sets of skills, processes, and routines, developed within the operations management system, that are regularly used in solving its problems through configuring its operational resources” (p. 726). Recently, Karna et al. (2015) differentiate five categories of ordinary capabilities: 1) operations/processes, 2) product/service/quality, 3) organization/structure/processes, 4) resources/assets, and 5) customer/supplier relationships. In this thesis, we are going to focus on the last of these categories.

In contrast, Helfat and Peteraf (2003, p.999) argue that "dynamic capabilities do not directly affect output for the firm in which they reside, but indirectly contribute to the output of the firm through an impact in operational capabilities". Teece (2007) identifies in turn that operational capabilities help an organization’s technical fitness by ensuring its day-to-day operational efficiency, whereas dynamic capabilities sustain a firm's evolutionary fitness, thus generating long-run competitive success. Besides, Pavlou and El Sawy (2001) propose that dynamic capabilities might help managers to extend, modify, and reconfigure existing operational capabilities in turbulent environments. The first-order or dynamic capabilities are dedicated to the modification of ordinary capabilities, producing changes in the firm’s products or production processes, or making new ordinary capabilities (Cepeda and Vera, 2007).

Most studies framed within the dynamic capabilities view (DCV) certainly highlight the strong connection between this set of higher order resources and capabilities, namely dynamic capabilities, and the attainment and renewal of competitive advantages (Vivas-López, 2005).

In this vein, Martelo-Landroguez et al. (2011) propose that organizations are able to increase customer value by identifying and effectively fostering adequate combinations of dynamic capabilities. Furthermore, dynamic capabilities may provide firms with the necessary doses of flexibility that might enable them to adjust to uncertain and changing scenarios and to develop product, process and managerial innovations. Similarly, Chaharbaghi, Adcroft and Willis (2005) argue that a strategic combination of organizational transformability and dynamic capabilities are vital in explaining the organizations' survival and renewal.

In spite of the possible discrepancies from the initial contributions (Teece et al., 1997; Eisenhardt and Martin, 2000; Zollo and Winter, 2002), there has already appeared a fairly sharp agreement on the core elements that define dynamic capabilities: 1) level of environmental change, 2) organizational processes or routines, 3) resources configuration, 4) managers' decision making, and 5) learning mechanisms. Next, Table 11 shows the main differences between ordinary and dynamic capabilities. It allows us to distinguish the characteristics of these topics.

Table 11. Some differences between ordinary and dynamic capabilities

	Ordinary capabilities	**Dynamic capabilities**
Purpose	Technical efficiency in business functions	Achieving congruence with customer needs and with technological and business opportunities
Mode of attainability	Buy or build (learning)	Build (learning)
Tripartite schema	Operate, administrate, and govern	Sense, seize, and transform
Key routines	Best practice	Signature processes
Managerial emphasis	Cost control	Entrepreneurial asset orchestration and leadership
Priority	Doing things right	Doing the right things
Imitability	Relatively imitable	Inimitable
Result	Technical fitness (efficiency)	Evolutionary fitness (innovation)

Source: Own elaboration based on Teece (2014)

2.4.2. Delimitation of the concept of dynamic capabilities

The dynamic capability theory is an extension of the resource-based view (RBV) of the company earlier developed by Barney (1991) and Peteraf (1993) in reply to very active environments.

Although multiple definitions can be found in the literature, dynamic capabilities can be defined as the capacity that allows a firm to integrate, build, and reconfigure internal and external competencies to quickly address fluctuating environments. This is the sense in which Teece, Pisano, and Shuen (1997) introduced the term of dynamic capabilities in the article entitled “Dynamic capabilities and strategic management”. This paper is considered the most influential study on dynamic capabilities, together with a recently developed new framework of dynamic capabilities (Teece, 2007; Teece, 2014). This term is still used in our days, although, over the years, many authors have attempted to redefine and expand the concept of dynamic capabilities, adjusting it to the particular context of the moment. Authors such as Eisenhardt and Martin (2000); Zollo and Winter (2002); Helfat and Peteraf (2003); Zott (2003); Winter (2003); Zahra, Sapienza, and Davidsson (2006); Teece (2007); Cepeda and Vera (2007) have contributed with their particular view and understanding of dynamic capabilities. However, they have failed to provide a brief and clear definition of dynamic capabilities and a consensus as to its conceptualization has not yet been reached (Protogerou, Caloghirou, and Lioukas, 2012). As a consequence, this produces some misunderstanding. More recently, Peteraf, Di Stefano and Verona (2013) consider the origin of the confusion to appear very soon, between what they called “seminal papers” (Teece et al., 1997; and Eisenhardt and Martin, 2000). What is certain is that, although the concept was born and developed linked to strategic management, the literature shows how researchers have paid great attention to its relationship with an increasingly broad variety of aspects which, jointly with its possible applications to different areas, has critically affected the definition of dynamic capabilities.

In this line, we can find definitions such as the one provided by Eisenhardt and Martin (2000) that presents dynamic capabilities as detailed and recognizable processes which especially comprise the development of products, strategic decision-making and the management of alliances. Zahra et al. (2006) describe dynamic capabilities as the firm’s ability to reconfigure organizational resources and routines in the form imagined and considered to be appropriate through the main decisions. Whereas, in their subsequent study Helfat et al. (2007, p.4) define them as "the ability to perform a task in at least a minimally acceptable manner". Recently, the term has been used to refer to situations in which managers generate, cover, and adapt the ways in which companies make a living, helping to clarify the connection between the quality of managerial decisions, strategic alteration, and organizational yield (Helfat and Martin, 2014). Table 12 presents several definitions of dynamic capabilities employed in key studies.

Table 12. Main definitions of dynamic capabilities

Autor	Definition

Teece & Pisano (1994, p. 537)	Timely responsiveness and rapid and flexible product innovation, along with the management's capability to effectively coordinate and redeploy internal and external competences.
Teece, Pisano & Shuen (1997, p. 516)	The firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.
Eisenhardt & Martin (2000, p. 1006)	The firm's processes that use resources-specifically the processes to integrate, reconfigure, gain, and release resources-to match and even create market change; dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve and die.
Teece (2000, p. 36)	The ability to sense and then seize opportunities quickly and proficiently.
Griffith & Harvey (2001, p. 597)	Dynamic Capabilities is a combination of resources that are difficult-to-imitate, including an effective coordination of inter-organizational relationships, on a global basis that can provide a firm with a competitive advantage.
Pavlou & El Sawy (2001, p,.239)	Dynamic capabilities have been proposed as a means for addressing turbulent environments by helping managers extend, modify, and reconfigure existing operational capabilities into new nes that better match the environment.
Zollo & Winter (2002, p. 340)	A dynamic capability is a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness.
Lee, Lee & Rho (2002, p. 734)	Dynamic capabilities are conceived as a source of sustainable advantage in Schumpeterian regimes of rapid change.
Adner & Helfat (2003, p .1012)	The capabilities with which managers build, integrate, and reconfigure organizational resources and competences.
Helfat & Peteraf (2003, p 999)	Dynamic capabilities do not directly affect output for the firm in which they reside, but indirectly contribute to the output of the firm through an impact on operational capabilities
Winter (2003, p. 991)	Those (capabilities) that operate to extend, modify, or create ordinary capabilities.
Zahra, Sapienza & Davidsson (2006, p. 918)	The abilities to reconfigure a firm's resources and routines in the manner envisioned and deemed appropriate by its principal decision-maker(s).
Cepeda & Vera (2007, p. 427)	Processes to reconfigure the resources and operative routines of a company that will allow us to take the main decisions.
Helfat et al. (2007, p. 4)	The ability to perform a task in at least a minimally acceptable manner.
Teece (2007, p. 1319)	Dynamic capabilities can be disaggregated in the capacity (a) to sense and shape opportunities and threats, (b) to seize opportunities, and (c) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets.
Pavlou & El Sawy (2011, p. 239)	Dynamic capabilities have been proposed as a means of addressing turbulent environments by helping managers to extend, modify, and reconfigure existing operational capabilities into new ones that better match the environment.
Helfat & Martin (2014, p. 1)	The capabilities with which managers create, extend, and modify the ways in which firms make a living helps to explain the relationship between the quality of managerial decisions, strategic change, and organizational performance.

By way of summary, we see that there are many authors who, following Teece et al. (1997), have defined dynamic capabilities as skills, capabilities, processes or routines. We also see that as all the definitions tend to deal with the change in the company's internal components as a key part of its dynamic capabilities.

2.4.2.1. Dynamic capabilities approach

The importance of dynamic capabilities has been such that the literature developed a new vision called the dynamic capabilities approach.

The article of Teece, Pisano and Shuen (1997) collects a complete synthesis of all the literature of the previous few years related to the theoretical vision involving process and technological change. It highlights the fact that in all these works there is a common denominator which is an emphasis on and interest in company-specific dynamic capabilities. Nelson (1991) indicates that it is the organizational differences and not having, for example, a higher level of technology that determines lasting differences between organizations and which are not easily imitable among them. Particularly relevant are the differences between companies with skills to generate and create through innovation, rather than the level of technology itself. This is due to the fact that there are certain technologies that are better understood and easier that the company's own dynamic capabilities.

Teece et al., (1997) recognizes three frameworks or paradigms where all the contributions to the theory of the literature that tries to recognize the sources of competitive advantage among the organizations are grouped together. That is, what is the origin or the reason why companies obtain different performances, returns, results: in short, different outputs. With this identification of the paradigms, these authors offer a fourth paradigm termed the dynamic capabilities approach.

The first and main paradigm in the field was the competitive forces approach established by Porter (1980). It is based on the paradigm of industrial organization (Mason, 1948; Bain, 1960). The structure of the industry, the entrance barriers and the position determine differences of managerial results and, therefore, there are strategic problems to be solved. It highlights the actions that a firm can take to generate competitive defendable places against market forces (Porter, 1980).

The second approach is the theory of business strategy. In this case, the competitors will act based on the forecasts or expectations of how others will operate, and the strategic problem to be solved is based on the interaction between these competitors (Saphiro, 1989). According to Teece et al. (1997), this strategic approach uses the tools of game theory and, accordingly, indirectly views competitive results as a purpose of the efficiency with which companies keep their competitors off balance through considered savings, signing assessing strategies, and regulating evidence.

A third approach is referred to as the theory based on resources and capabilities: the "resource-based perspective". In this case, business performance differences reside in the greater or lower availability of resources versus the competition, and their protection or insulation against them (Penrose, 1959; Wernerfelt, 1984).

Finally, the approach of dynamic capabilities tries to identify those dimensions of the capacities of the company that can be a cause of competitive advantage, and tell how the combinations of resources and capacities can be opened, established and protected. This approach develops management capabilities and integrates the new sources of competitive advantage, such as human resources, product and process development, intellectual property, organizational learning and technology transfer (Teece et al., 1997). The dynamic capabilities approach is an extension of the theory based on resources and capabilities (Makadok, 2001). While the RBV emphasizes the collection of resources (Barney, 1991), the dynamic capabilities approach focuses on its renewal through its reconfiguration into new functional skills (Teece et al., 1997).

In addition to these four approaches, the knowledge-based approach is an extension of the well-known theory based on resources and capabilities (RBV) and the dynamic capabilities approach. The authors, who defend the knowledge-based approach of the company (Nonaka, 1994; Spender, 1996), consider that the main objective of the company is to create and apply knowledge. The relevant aspects of this approach are: that the company is a store of knowledge; to know how to access this knowledge; the creation of an enabling environment in the company for the acquisition of that knowledge and also the consideration of knowledge as an asset (Davenport, De Long and Beers, 1998).

2.4.2.2. Microfoundations of dynamic capabilities

The dynamic capabilities approach determines that the creation and accumulation of wealth in turbulent and changeable environments depends largely on of organizational, technological and management processes. In other words, identifying new opportunities, organizing them effectively and adopting them is more relevant to the strategy itself, understanding strategy as the conduct to ward off competitors, increase the cost of entry and exclude new potential rivals.

Several authors, such as Helfat and Peteraf (2009) and Teece (2009), have shown that firms need to be arranged in line with their resources and with the needs of the market through the perception of threats and opportunities, the assessment of occasions and threats, and the management and reconfiguration of resources. Hence, dynamic capabilities is decomposed into three dimensions from the process perspective (Figure 3): 1) “sensing” or identifying and assessing opportunities and threats, 2) “seizing” or grasping opportunities, and 3) “reconfiguring” or preserving attractiveness through improving, protecting, combining and, when necessary, reconfiguring the business companies’ intangible and tangible assets (Teece, 2007). Then, the dimensions of dynamic capabilities can be used to obtain, integrate and reconfigure the company’s resources. This study uses the three dimensions of dynamic capabilities when measuring dynamic capabilities.

Figure 3. Dimensions of dynamic capabilities

- Sensing (and shaping) opportunities and threats

The sensing capability is the process of identifying deducing and following new opportunities in an atmosphere of change. Company should sense the atmosphere to gather external information and knowledge about the market opportunities, competitor activity, customers’ needs and new technologies, so managers can develop new product and process innovation. Teece et al. (2007) define this dimension as “the ability to calibrate the requirements for change and to effectuate the necessary adjustments would appear to depend on the ability to scan the environment, to evaluate markets and competitors, and to quickly accomplish reconfiguration ahead of competition” (p. 521).

In the words of Pavlou and El Sawy (2011), the three basic routines of the sensing capability are: i) creating (Galunic and Rodan, 1998), ii) distributing (Kogut and Zander, 1996), and iii) responding to market intelligence (Teece, 2007). The first routine consists in identifying customer needs taking into account market trends and opportunities, and recognizing problems. The second routine is the distribution of market intelligence. This refers to the interpretation of market intelligence, making sense of events and development and discovering new occasions. Finally, the third routine relates to introducing plans to capitalize on market intelligence, and pursuing specific market sectors with strategies to seize the new market opportunities (Teece, 2007).

Therefore, the sense-making process is one of the main organizational capacities for a firm to recognize the advantages and disadvantages of current resource bases for survival in the changing environment (Zahra and George, 2002). So, the process of sensing serves to identify and shape opportunities. To do so, companies scan, search and explore markets (local and distant), and obtain new opportunities and receive potential threats (Nelson and Winter, 1982), while simultaneously learning about customer needs to commercialize new products or services.

- Seizing opportunities

After detected a new market or technological opportunity, the next phase is to assess the opportunity "seizing". Seizing opportunities consists in the assessment of present and future capabilities, and also potential investments in the significant technologies and designs that are most likely to attain a marketplace acceptance (O'Reilly III and Tushman, 2008). This step serves to evaluate and choose the best opportunities and threats in the environment transformation that will affect the firm's performance in terms of profits, growth and competitive advantage.

So, in a changing environment, companies should construct a correct material or immaterial information system with the support of information technology to make available an operational stage for a fast and correct decision making to timely repeat the operative actions and staff behaviors (Sher and Lee, 2004). What is more, companies must also quickly deal with diverse conflicts in the strategic decision-making process, and approve fast solutions for disappointed clients (Li and Liu, 2014).

- Reconfiguring

The third step of dynamic capabilities is the creation, modification and recombination or "reconfiguring" of the resource base. This involves the reallocation of resources, so that the new combination boosts the value of the company. A reconfiguration process gives the company the ability to make decisions about environmental requirements, discard obsolete practices and allow it to obtain improved and effective results.

The reconfiguration can be achieved through changes in the organizational structure that lead to greater business performance. Strategic adjustments in management include the rearrangement of assets to upgrade the company value, and the introduction of incentives that help to ensure that managers and shareholders support the development of the company's performance. According to Teece (2006), "a key to sustained profitable growth is the ability to recombine and reconfigure assets and organizational structures (…) as markets and technologies change" (p. 38).

Then, reconfiguration denotes a break from the firm's past since it can further modify the organization's accumulated advantage base. This is important to a supplementary result of competitive advantage and firm performance, and to new situations and paths (O'Reilly and Tushman, 2007; Wilden, Gudergan, Nielsen and Lings, 2013; Helfat and Peteraf, 2015).

2.5. Theoretical foundations of Relationship learning

2.5.1 Delimitation of the concept of relationship learning

The concept of relationship learning (RL) is a relatively new term which until now has not been extensively studied. There are few authors who have defined the term in their research work. Recent theoretical works posit that business partnerships can create value for a firm's competitive advantage (Vargo and Lusch, 2004). For this reason, companies work toward collaborating with specific partners that enable them to augment their profits.

The Resource-based view (RBV) focuses on detailed relational resources which may be measured based on the profits gained through relationships, among other aspects. Because partners that deliver higher returns will be greatly valued, firms will commit themselves to establishing, developing, and maintaining relationships with these partners (Morgan and Hunt, 1994).

The concept of relationship learning can relate to similar concepts, such as inter-organizational knowledge, inter-organizational relationships or learning cooperation.

For Anders (2006) the term inter-organizational knowledge sharing is a process of acquirement, through the representation of flows of knowledge from external stocks to within the organizations. This process enables mutual learning to take place between organizations with long-standing relationships, contributing to the increased survival of the participating companies by reducing the coordination costs of activities and improving the performance of routine tasks (In and Rai, 2008; Nodari et al., 2016). According to Cheng (2011), inter-organizational relationships are established, maintained and enhanced to achieve competitive advantages for all the parties involved. Thus, different types of relationships are formed based on the type of collaboration, from close collaborative product development to simple buy-and-sell interaction. Learning in coopetition refers to the companies that simultaneously emphasize cooperative and competitive behavior between organizational units, at the same time as developing the capacity to replicate and effectively share knowledge within the firms (Grant, 1996; Tsai, 2002).

However, the concept of relationship learning is deeper, complex and evolved, since the mere fact of sharing does not imply learning.

Selnes and Sallis (2003) were the first to coin this concept and defined it as "a joint activity in which two parties strive to create more value together than they would create individually or with other partners". Cheung, Myers and Mentzer (2011) refer to relationship learning as a joint activity between a supplier and a buyer in which two parties share information. Others have argued that relationship learning is a joint activity between the organization and one or more parts- supplier, customer, partner, etc.- in which the purpose is to share information (Leal-Rodriguez et al., 2014). Relationship learning is a multidimensional construct consisting of information sharing, joint sensemaking of this information and knowledge integration into the firm's memory. These three dimensions define the environment in which knowledge sharing takes place between the transmitter and the receiver (Leal-Rodriguez, et al., 2014).

According to the theory of resource dependence (Pfeffer and Salancik, 1978), organizations build collaborative relationships in order to respond to uncertainty. Consequently, they are be able to organize their resources. Therefore, companies should facilitate the exchange of information with different customers and suppliers to further their knowledge base, skills and competitiveness through shared learning, updating their behavior accordingly.

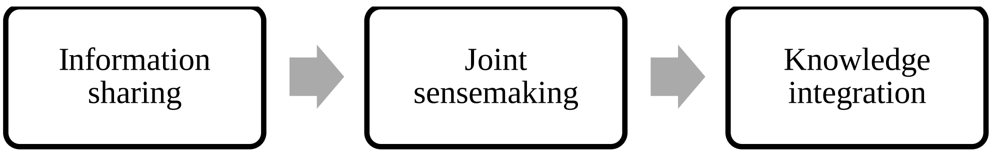
Due to the complexity of the process, the relations change according to the learning ability. This is why some relations work better than others, since they have mechanisms adapted for learning (Selnes and Sallis, 2003). For the parts to interact and be able to reach a mutual understanding, it is important to develop routines or formal and informal procedures. The integration of the specific knowledge of the relations of suppliers and buyers improves their ability to meet the needs of their partners. Through several mechanisms, RL can be very helpful in achieving this purpose.

With the ability of RL, companies may favor a strategy of coopetition, generating competitive advantages that enhance its results. Such strategic targets as the distribution of risks and the outsourcing of its chain of value and organization functions can be attained (Gulati, Nohria and Zaheer, 2000). Notwithstanding, the organizations might suffer certain risks in the collaborative processes due to the exchange of sensitive information, investments, the creation of competitors through the collaboration, the differences in work styles of the organizations or cultural disparities.

2.5.2. Dimensions of relationship learning

According to Selnes and Sallis (2003), relationship learning involves three dimensions- information sharing, joint sensemaking of this information, and knowledge integration into the firms' memory (Figure 4).

Figure 4. Dimensions of relationship learning



- Information sharing

The information sharing in the customer and supplier relationship is a starting point and a necessary element of relationship learning (Selnes and Sallis, 2003). Vargo and Lusch (2004) prove that information is the main flow between firms and groups. Relationship learning allows companies to have information about the resources (resorts) to be used, the market structure, the clients, and the profitable technologies to achieve the strategic objectives that will favor scale and scope economies (Gulati et al., 2000). Information sharing promotes the ability of firms to provide the necessary products to clients, cycle time reduction, increase on-time and reduce costs (Vargo and Lusch, 2004).

Relationship learning enables mutual learning between two or more companies. For Lee (2001), the information or knowledge sharing can involve explicit and tacit knowledge. Explicit knowledge can be reports, manuals, models, business proposals and other encoded representations, and tacit knowledge the exchange of experiences, expertise and activities that enable learning between individual levels, departments, groups and across companies.

Some examples of information sharing are: information about the needs and changes in the behavior of customers, the structures of the markets, information associated with technological changes or information about financial or strategic affairs (Selnes and Sallis, 2003). In particular, buyers and suppliers can achieve their strategic objectives through risk-sharing and outsourcing of the stages of the value chain and organizational functions. Thus, the firm's operational efficiency is achieved through the exchange of information which benefits both members (Gulati et al., 2000).

- Joint Sensemaking

In the last years, the management of joint sensemaking activities has become increasingly important given its augmented role in new product development and knowledge management (Leal-Rodríguez et al., 2014). Joint sensemaking consists in the development of insight, knowledge, and associations between past actions, the effectiveness of those actions, and future actions (Fiol and Lyles, 1985).

Sense (2007, p. 406) argues that "social constructivist theories of learning emphasize social relations, sensemaking, informality, collective action and conversations within the workplace, and learning is also considered an integral part of generative social practice within the context". To do so, organizations vary in the ways in which they make sense of the same information and hence have different mechanisms involved in the process of joint sensemaking that contribute to socializing people's tacit knowledge. These mechanisms include information sharing forums, meetings and cross-functional teams, and are designed with the aim of creating learning between organizations (Selnes and Sallis, 2003). For example: the Ford company have a platform, Ford Online, where the firm's employees send emails or share information with companies located in other countries.

As a result, studies are focused on informal relations within teams and organizational subunits (Levin and Cross, 2004), or on external informal relations (Cummings, 2004), or on relations between subunits within an organization (Gupta and Govindarajan, 2000). According to Cheung, Myers and Mentzer (2011) innovations can be developed in many parts of the supply chain, but particularly through direct partnerships. Moreover, these authors affirm that the management of joint sensemaking activities helps the results related to the performance by increasing new product and process innovations. An example of a joint sensemaking action could be the establishing of joint teams with suppliers, partners and customers with the intention of considering strategic issues or resolving operational problems.

In particular, it is important for the environmental context to add heterogeneity, variety and complexity to the exchange of information. Therefore, companies should develop structures in which the firm's members share knowledge and experiences around the world through which they can develop routines, redesign products and reorganize process flows (Mesquita et al., 2008). This, in turn, helps decrease costs and increase on-time deliveries and product quality (Cheung et al., 2011).

- Knowledge integration

Integration is defined as an indicator for measuring the quality of the state of collaboration that exists between departments which required a unifying of effort due to the demands of the environment (Cheung et al., 2011). Generally, this definition is applied to departments within a company, yet the notion of integration can also be used to understand relations between organizational units from different companies, where integration consists of an alignment of interests (cooperation), as well as an alignment of actions (coordination) (Gulati et al., 2005), and how this benefits relationship performance (Mesquita et al., 2008).

Companies carry out an integration of knowledge when they store specific knowledge, routines, beliefs and values acquired through the formal and informal relationships of the teams and organizational subunits. Knowledge integration is characterized by evaluating markets, and the frequent updating of databases, processes and communication techniques between partners. Principally, these are characterized by being updated frequently so that the quality of knowledge flows does not decrease. According to Selnes and Sallis (2003, p. 84) “more than two-thirds of all technical development collaboration is done through informal interpersonal networks”. Relationships act as repositories for information and assist in the solution of the problems of each firm (Leal-Rodríguez et al., 2014). Firms that focus on global integration promote a holistic view of global operations and coordinate interdependent processes across organizations (Cheung et al., 2011).

Companies develop different methods of integration of knowledge. Some examples of knowledge integration tools are adjusting the understanding of the end-user's needs and behavior, and trends in technology; meeting face-to-face to refresh the personal network in the relationship; evaluating and adjusting routines in order-delivery processes, updating the formal contracts in relationships; and assessing and updating information about the relationship stored in the firm's electronic databases. Integration relationships make continuous information exchange possible. This enables anticipating market changes and reacting in accordance with them (Leal-Rodríguez et al., 2013).

However, some methods of integration affect the quality of knowledge flows over functional specialties. Cross function knowledge integration is categorized by the regular updating and evaluating of processes, databases, markets, and communication techniques between partners. Yet implanted or integrated relationships aid the continuous interchange of detailed information. This, in turn, benefits a firm's ability to anticipate unforeseen market changes and react accordingly. For instance, integrative tools such as centralized databases relative to products, services, markets and methods help facilitate knowledge transfers. Finally, the integration of detailed knowledge into the relationship raises the ability of both the supplier and the buyer to readily meet their partners' requirements more. This is attained by a better understanding of the technological demands related to the methods, techniques and product design applications of the partner firm (Cheung et al., 2011; Leal-Rodríguez et al., 2014).

Therefore, these three dimensions of relationship learning, information sharing, joint sensemaking and knowledge integration, are very important in the development of inter-organizational learning.

2.6. References

Aguilera-Caracuel, J., & Ortiz-de-Mandojana, N. (2013). Green innovation and financial performance: An institutional approach. *Organization & Environment*, *26*(4), 365-385.

Ahuja, G., & Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strategic Management Journal*, *22*(3), 197-220.

Albort-Morant, G., Leal-Millán, A., & Cepeda-Carrión, G. (2016). The antecedents of green innovation performance: A model of learning and capabilities. *Journal of Business Research, 69*(11), 4912-4917.

Anders, P. N. (2006). Understanding dynamic capabilities through knowledge management. *Journal of Knowledge Management, 10*(4), 59-71.

Azzone, G., & Noci, G. (1998). Seeing ecology and “green” innovations as a source of change. *Journal of Organizational Change Management, 11*(2), 94-111.

Bain, J. S. (1960). Industrial Organization.

Baregheh, A., Rowley, J., & Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. *Management Decision, 47*(8), 1323-1339.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Barney, J. B. (1986). Strategic factor markets: Expectations, luck, and business strategy. *Management Science, 32*(10), 1231-1241.

Beise, M., & Rennings, K. (2005). Lead markets and regulation: a framework for analyzing the international diffusion of environmental innovations. *Ecological Economics*, *52*(1), 5-17.

Bierly, P., & Chakrabarti, A. (1996). Generic knowledge strategies in the US pharmaceutical industry. *Strategic Management Journal*, *17*(S2), 123-135.

Bouyssou, D., & Marchant, T. (2011). Bibliometric rankings of journals based on impact factors: An axiomatic approach. *Journal of Informetrics, 5*(1), 75-86.

Brundtland, G. H. (1987), Our Common Future: The Report of the World Commission on Environment and Development, Oxford University Press, Oxford.

Carrillo-Hermosilla, J., Del Río, P., & Könnölä, T. (2010). Diversity of eco-innovations: Reflections from selected case studies. *Journal of Cleaner Production, 18*(10), 1073-1083.

Cepeda, G., & Vera, D. (2007). Dynamic capabilities and operational capabilities: A knowledge management perspective. *Journal of Business Research, 60*(5), 426-437.

Cepeda-Carrion, G., Cegarra-Navarro, J. G., & Jimenez-Jimenez, D. (2012). The effect of absorptive capacity on innovativeness: Context and information systems capability as catalysts. *British Journal of Management, 23*(1), 110-129.

Chaharbaghi, K., Adcroft, A., & Willis, R. (2005). Organisations, transformability and the dynamics of strategy. *Management Decision, 43*(1), 6-12.

Chang, C. H. (2011). The influence of corporate environmental ethics on competitive advantage: the mediation role of green innovation. *Journal of Business Ethics, 104*(3), 361-370.

Charter, M., & Clark, T. (2007). Sustainable Innovation: Key conclusions from sustainable innovation conferences 2003-2006 organised by The Centre for Sustainable Design. The Centre for Sustainable Design, University College for the Creative Arts.

Chen, C. J., & Huang, J. W. (2009). Strategic human resource practices and innovation performance—The mediating role of knowledge management capacity. *Journal of Business Research, 62*(1), 104–114.

Chen, Y. S. (2008). The driver of green innovation and green image – green core competence. *Journal of Business Ethics, 81*(3), 531-543.

Chen, Y. S., Chang, C. H., & Wu, F. S. (2012). Origins of green innovations: the differences between proactive and reactive green innovations. *Management Decision, 50*(3), 368-398.

Chen, Y. S., Chang, C. H., Lin, Y. H. (2014). The determinants of green radical and incremental innovation performance: Green shared vision, green absorptive capacity, and green organizational ambidexterity. *Sustainability, 6*(11), 7787-7806.

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics, 67*(4), 331-339.

Cheng, J. (2011). Interorganizational relationships and knowledge sharing in green supply chains-Moderating by relational benefits and guanxi. Transportation Review. Part E: *Logistics and Transportation Review, 47*(6), 837-849.

Chesbrough, H. (2003). The logic of open innovation: managing intellectual property. *California Management Review, 45*(3), 33-58.

Chesbrough, H. W., & Teece, D. J. (1996). When is virtual virtuous. *Harvard Business Review, 74*(1), 65-73.

Cheung, M. S., Myers, M. B., & Mentzer, J. T. (2011). The value of relational learning in global buyer-supplier exchanges: a dyadic perspective and test of the pie-sharing premise. *Strategic Management Journal, 32*(10), 1061-1082.

Chiou, T. Y., Chan, H. K., Lettice, F., & Chung, S. H. (2011). The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. Transportation Research Part E: *Logistics and Transportation Review, 47*(6), 822-836.

Church, R., Hecox, W., Dresners, S., & Edwards, A. (2008) Sustainable development: oxymoron? Or opposed by morons? Sustainable Development – EV 141. Colorado College.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly,* 128-152.

Colotta, I., Shi, Y., & Gregory, M. (2003). Operation and performance of international manufacturing networks. *International Journal of Operations and Production Management, 23*(10), 1184–1206.

Comisión Europea (1995). El Libro Verde de la innovación.

Cummings, J. N. (2004). Work groups, structural diversity, and knowledge sharing in a global organization. *Management Science, 50*(3), 352-364.

Davenport, T. H., & Prusak, L. (1998). How organizations manage what they know. Harvard Business School Press, Boston.

Davenport, T. H., De Long, D. W., & Beers, M. C. (1998). Successful knowledge management projects. *MIT Sloan Management Review, 39*(2), 43.

EIO (Eco-Innovation Observatory) (2013). Europe in transition. Paving the way to a green economy through Eco-innovation. Eco-innovation Observatory Annual Report 2012. Funded by the European Commission. Brussels: DG Environment.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they?. *Strategic Management Journal*, *21*(10-11), 1105-1121.

Fernández, J. C. R. (2003). Aprendizaje organizativo y creación de conocimiento en el desarrollo de competencias distintivas tecnológicas: un modelo dinámico basado en variables stocks y flujos.

Fiol, C. M., & Lyles, M. A. (1985). Organizational learning. *Academy of Management Review*, *10*(4), 803-813.

Fussler, C., & James, P. (1996). A breakthrough discipline for innovation and sustainability. Pitman Publishing: London, UK.

Galunic, D. C., & Rodan, S. (1998). Research notes and communications: resource recombinations in the firm: knowledge structures and the potential for Schumpeterian innovation. *Strategic Management Journal*, *19*(12), 1193-1201.

Gluch, P., Gustafsson, M., & Thuvander, L. (2009). An absorptive capacity model for innovation and performance in the construction industry. *Construction Management and Economics*, *27*(5), 451-464.

Gopalakrishnan, S., & Damanpour, F. (1994). Patterns of generation and adoption of innovation in organizations: Contingency models of innovation attributes. *Journal of Engineering and Technology Management*, *11*(2), 95-116.

Grant, R. M. (1991). The resource-based theory of competitive advantage: implications for strategy formulation. *California Management Review*, *33*(3), 114-135.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, *17*(S2), 109-122.

Grant, R. M., & Baden-Fuller, C. (2004). A knowledge accessing theory of strategic alliances. *Journal of Management Studies*, *41*(1), 61-84.

Gulati, R., Lawrence, P. R., & Puranam, P. (2005). Adaptation in vertical relationships: Beyond incentive conflict. *Strategic Management Journal, 26*(5), 415-440.

Gulati, R., Nohria, N., & Zaheer, A. (2000). Strategic networks. *Strategic Management Journal*, 203-215.

Gupta, A. K., & Govindarajan, V. (2000). Knowledge flows within multinational corporations. *Strategic Management Journal, 21*(4), 473-496.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review, 20*(4), 986-1014.

Hashim, R., Bock, A. J., & Cooper, S. (2015). The Relationship between Absorptive Capacity and Green Innovation. World Academy of Science, Engineering and Technology, International *Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering, 9*(4), 1049-1056.

Hautamäki, A. (2010). Sustainable innovation. A New Age of Innovation and Finland's Innovation Policy, Edita, Helsinki, Sitra Reports, 87.

Hautamäki, A., & Oksanen, K. (2016). Sustainable innovation: solving wicked problems through innovation. In Open Innovation: A Multifaceted Perspective: Part I (pp. 87-110).

Helfat, C. E., & Martin, J. A. (2014). Dynamic managerial capabilities review and assessment of managerial impact on strategic change. *Journal of Management*, DOI: 0149206314561301.

Helfat, C. E., & Peteraf, M. A. (2003). The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal, 24*(10), 997-1010.

Helfat, C. E., & Peteraf, M. A. (2015). Managerial cognitive capabilities and the microfoundations of dynamic capabilities. *Strategic Management Journal, 36*(6), 831-850.

Helfat, C. E., & Winter, S. G. (2011). Untangling dynamic and operational capabilities: Strategy for the (N) ever-changing world. *Strategic Management Journal, 32*(11), 1243-1250.

Helfat, C., & Peteraf, M. (2009). Understanding dynamic capabilities: progress along a developmental path. *Strategic Organization, 7*(1), 91.

Hemmelskamp, J. (1997). Environmental policy instruments and their effects on innovation. *European Planning Studies, 5*(2), 177-194.

Hemmelskamp, J. (2000). Environmental taxes and standards: An empirical analysis of the impact on innovation. In Innovation-Oriented Environmental Regulation (pp. 303-329). Physica-Verlag HD.

Henriques, I., & Sadorsky, P. (1999). The relationship between environmental commitment and managerial perceptions of stakeholder importance. *Academic Management Journal, 42*(1), 87-99.

Horbach, J. (2008). Determinants of environmental innovation—new evidence from German panel data sources. *Research Policy, 37*(1), 163-173.

Im, G., & Rai, A. (2008). Knowledge Sharing Ambidexterity in Long-Term Interorganizational Relationships. *Management Science, 54*(7),1281-1296.

Jansen, J. J., Van den Bosch, F. A., & Volberda, H. W. (2003). Managing potential and realized absorptive capacity: Antecedents and consequences. In DRUID conference on Creating, Sharing, and Transferring Knowledge.

Johannessen, J. A., Olsen, B., & Lumpkin, G. T. (2001). Innovation as newness: what is new, how new and new to whom?. *European Journal of Innovation Management, 4*(1), 20-31.

Karna, A., Richter, A., & Riesenkampff, E. (2015). Revisiting the role of the environment in the capabilities–financial performance relationship: A meta-analysis. *Strategic Management Journal, 37*(6), 1154-1173.

Katz, B., & Du Preez, N. (2008). The role of knowledge management in supporting a radical innovation project. In Methods and Tools for Effective Knowledge Life-Cycle-Management (pp. 331-345). Springer Berlin Heidelberg.

Kearns, G. S., & Sabherwal, R. (2006). Strategic alignment between business and information technology: a knowledge-based view of behaviors, outcome, and consequences. *Journal of Management Information Systems, 23*(3), 129-162.

Kemp, R., & Pearson, P. (2007). Final report MEI project about measuring eco-innovation. UM Merit, *Maastricht*, *32*(3), 121-124.

Kemp, R., & Pearson, P. (2008). Measuring eco-innovation. Maastricht: United Nations University.

Kemp, R., Arundel, A., & Smith, K. (2001). Survey indicators for environmental innovation. Paper presented at the Conference Towards Environmental Innovation Systems in Garmisch-Partenkirchen.

Kim, L. (1998). Crisis construction and organizational learning: Capability building in catching-up at Hyundai Motor. *Organization Science*, *9*(4), 506-521.

Kimberly, J. R. (1981). Managerial innovation. Handbook of organizational design, 1(84), 104.

Klassen, R. D., & Whybank, D. C. (1999). The impact of environmental technologies on manufacturing performance. *Academy of Management Journal*, *42*(6), 599-615.

Klewitz, J., & Hansen, E. G. (2014). Sustainability-oriented innovation of SMEs: a systematic review. *Journal of Cleaner Production*, *65*, 57-75.

Kogut, B., & Zander, U. (1996). What firms do? Coordination, identity, and learning. *Organization Science*, *7*(5), 502-518.

Lai, S. B., Wen, C. T., & Chen, Y. S. (2003). The Exploration of the Relationship between the Environmental Pressure and the Corporate Competitive Advantage, 2003 CSMOT Academic Conference (National Chiao Tung University, Hsin-Chu).

Lane, P. J., & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, *19*(5), 461-477.

Lane, P. J., Koka, B. R., & Pathak, S. (2006). The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy of Management Review*, *31*(4), 833-863.

Lane, P. J., Salk, J. E., & Lyles, M. A. (2001). Absorptive capacity, learning, and performance in international joint ventures. *Strategic Management Journal*, *22*(12), 1139-1161.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, *27*(2), 131-150.

Leal-Millán, A., Albort-Morant, G., Leal-Rodríguez, A., & Ariza-Montes, A. (2017). Relationship Learning Strategy as a Mechanism of Network and the Effectiveness of Green Innovation. In Cooperative and Networking Strategies in Small Business (pp. 81-95). Springer International Publishing.

Leal-Millán, A., Roldan, J. L., Leal-Rodríguez, A. L., & Ortega-Gutiérrez, J. (2016). IT and relationship learning in networks as drivers of green innovation and customer capital: Evidence from the automobile sector. *Journal of Knowledge Management*, *20*(3).

Leal-Rodríguez, A. L., Roldán, J. L., Ariza-Montes, J. A., & Leal-Millán, A. (2014). From potential absorptive capacity to innovation outcomes in project teams: The conditional mediating role of the realized absorptive capacity in a relational learning context. *International Journal of Project Management, 32*(6), 894-907.

Leal-Rodríguez, A., Leal-Millán, A., Roldán-Salgueiro, J. L., & Ortega-Gutiérrez, J. (2013). Knowledge management and the effectiveness of innovation outcomes: The role of cultural barriers. *Electronic Journal of Knowledge Management, 11*(1), 62-71.

Lee, J. N. (2001). The impact of knowledge sharing, organizational capability and partnership quality on IS outsourcing success. *Information & Management, 38*(5), 323-335.

Leenders, M. A., & Chandra, Y. (2013). Antecedents and consequences of green innovation in the wine industry: the role of channel structure. *Technology Analysis & Strategic Management, 25*(2), 203-218.

Lettice, F., Wyatt, C., & Evans, S. (2010). Buyer–supplier partnerships during product design and development in the global automotive sector: Who invests, in what and when?. *International Journal of Production Economics, 127*(2), 309-319.

Levin, D. Z., & Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management Science, 50*(11), 1477-1490.

Li, D. Y., & Liu, J. (2014). Dynamic capabilities, environmental dynamism, and competitive advantage: Evidence from China. *Journal of Business Research, 67*(1), 2793-2799.

Luca, L. M. D., & Atuahene-Gima, K. (2007). Market knowledge dimensions and cross-functional collaboration: Examining the different routes to product innovation performance. *Journal of Marketing*, *71*(1), 95-112.

Makadok, R. (2001). Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic Management Journal*, *22*(5), 387-401.

Markusson, N. (2010). The championing of environmental improvements in technology investment projects. *Journal of Cleaner Production, 18*(8), 777-783.

Martelo Landroguez, S., Barroso Castro, C., & Cepeda-Carrión, G. (2011). Creating dynamic capabilities to increase customer value. *Management Decision*, *49*(7), 1141-1159.

Martelo-Landroguez, S., & Cegarra-Navarro, J. G. (2014). Linking knowledge corridors to customer value through knowledge processes. *Journal of Knowledge Management*, *18*(2), 342-365.

Mason, E. S. (1948). Current Status of the Monopoly Problem in the United States. The. *Harvard Law Review, 62*, 1265.

McDonald, R. E., & Madhavaram, S. (2007). What firms learn depends on what firms know: The implications of prior knowledge for market orientation. *Marketing Management Journal*, *17*(1).

Mesquita, L. F., Anand, J., & Brush, T. H. (2008). Comparing the resource-based and relational views: knowledge transfer and spillover in vertical alliances. *Strategic Management Journal*, *29*(9), 913–941.

Miller, D. J., Fern, M. J., & Cardinal, L. B. (2007). The use of knowledge for technological innovation within diversified firms. *Academy of Management Journal*, *50*(2), 307-325.77

Morgan, R. M., & Shelby D. H. (1994). The commitment-trust theory of relationship marketing. *The Journal of Marketing*, 20-38.

Mowery, D. C., & Oxley, J. E. (1995). Inward technology transfer and competitiveness: the role of national innovation systems. *Cambridge Journal of Economics*, *19*(1), 67-93.

Nelson, R. R. (1991). Why do firms differ, and how does it matter?. *Strategic Management Journal*, *12*(S2), 61-74.

Nelson, R. R., & Winter, S. G. (1982). The Schumpeterian tradeoff revisited. *The American Economic Review*, *72*(1), 114-132.

Nodari, F., Oliveira, M., & Maçada, A. C. G. (2016). Organizational performance through the Donation and Collection of Interorganizational Knowledge. *VINE Journal of Information and Knowledge Management Systems*, *46*(1), 85-103.

Nonaka, I. (1991). The knowledge-creating company. *Harvard Business Review*, *69*(6), 96–104.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, *5*(1), 14-37.

Nonaka, I., & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. Oxford university press.

O'Connor, G.C., Leifer, R., Paulson, A.S., & Peters, L.S. (2008). Grabbing Lighting: Building a Capability for Breakthrough Innovation, Jossey-Bass, San Francisco, CA.

O'Reilly, C. A., & Tushman, M. L. (2008). Ambidexterity as a dynamic capability: Resolving the innovator's dilemma. *Research in Organizational Behavior*, *28*, 185-206.

OCDE (2005). Oslo Manual. Directrices para la recogida e interpretación de información relativa a innovación.

OCDE-Eurostat (2005). Oslo Manual: Proposed guidelines for collecting and interpreting technological innovation data, OCDE, Paris.

Oltra, V., & Saint Jean, M. (2009). Sectoral systems of environmental innovation: an application to the French automotive industry. *Technological Forecasting and Social Change*, *76*(4), 567-583.

Organisation for Economic Co-operation and Development (OECD) (2009). Factbook 2009: Economic, Environmental and Social Statistics.

Pavlou, P. A., & El Sawy, O. A. (2011). Understanding the elusive black box of dynamic capabilities. Decision Sciences, 42(1), 239-273.

Pavón, J., & Goodman, R. A. (1981). El proceso de innovación. La planificación del desarrollo tecnológico: el caso español, proyecto Modeltec, Centro para el desarrollo tecnológico industrial, Madrid, 221-229.

Peattie, K. (1992). Green Marketing, Pitman Publishing, London, 64-78.

Penrose, E. T. (1959). The theory of the growth ofthe firm. New York: Sharpe.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. *Strategic Management Journal*, *14*(3), 179-191.

Peteraf, M., Di Stefano, G., & Verona, G. (2013). The elephant in the room of dynamic capabilities: Bringing two diverging conversations together. *Strategic Management Journal*, *34*(12), 1389-1410.

Pfeffer, J., & Salancik, G. R. (1978). The external control of organisations. New York, 175.

Porter, M. E., & Van der Linde, C. (1995) Green and competitive. *Harvard Business Review*, *73*(5), 120-134.

Porter, M. F. (1980). An algorithm for suffix stripping. *Program*, *14*(3), 130-137.

Prahalad, C. K., & Hamel, G. (1990). The Core Competence of the Corporation. *Harvard Business Review*, 79-91.

Protogerou, A., Caloghirou, Y., & Lioukas, S. (2012). Dynamic capabilities and their indirect impact on firm performance. *Industrial and Corporate Change*, *21*(3), 615-647.

Rennings, K. (2000). Redefining innovation—eco-innovation research and the contribution from ecological economics. *Ecological Economics*, *32*(2), 319-332.

Russo, M. V., & Fouts, P. A. (1997). A resource-based perspective on corporate environmental performance and profitability. *Academy of Management Journal*, *40*(3), 534-559.

Schiederig, T., Tietze, F., & Herstatt, C. (2012). Green innovation in technology and innovation management – an exploratory literature review. *R&D Management*, *42*, 180–192.

Schulz, M. (2001). The uncertain relevance of newness: Organizational learning and knowledge flows. *Academy of Management Journal*, *44*(4), 661-681.

Schumpeter, J. A. (1934). The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle (Vol. 55). Transaction publishers.

Selnes, F., & Sallis, J. (2003). Promoting relationship learning. *Journal of Marketing*, *67*(3), 80-95.

Sense, A. J., (2007). Structuring the project environment for learning. *International Journal Project Management, 25*(4), 405–412.

Sher, P. J., & Lee, V. C. (2004). Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information & Management*, *41*(8), 933-945.

Spender, J. C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, *17*(S2), 45-62.

Subramaniam, M., & Youndt, M. (2005) The Influence of Intellectual Capital on the types of innovative capabilities, *Academy of Management Journal*, *48*(3), 450–463.

Teece, D. J. (2006). Reflections on "profiting from innovation". *Research Policy*, *35*(8), 1131-1146.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319-1350.

Teece, D. J. (2009). Dynamic capabilities and strategic management: Organizing for innovation and growth. Oxford University Press on Demand.

Teece, D. J. (2014). A dynamic capabilities-based entrepreneurial theory of the multinational enterprise. *Journal of International Business Studies*, *45*(1), 8-37.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 509-533.

Todorova, G., & Durisin, B. (2007). Absorptive capacity: Valuing a reconceptualization. *Academy of Management Review, 32*(3), 774-786.

Tsai, W. (2002). Social structure of "coopetition" within a multiunit organization: Coordination, competition, and intraorganizational knowledge sharing. *Organization Science, 13*(2), 179-190.

Tseng, M. L., Huang, F. H., & Chiu, A. S. (2012). Performance drivers of green innovation under incomplete information. *Procedia-Social and Behavioral Sciences, 40*, 234-250.

Tseng, M. L., Wang, R., Chiu, A. S., Geng, Y., & Lin, Y. H. (2013). Improving performance of green innovation practices under uncertainty. *Journal of Cleaner Production, 40*, 71-82.

Van den Hooff, B., & De Ridder, J. A. (2004). Knowledge sharing in context: the influence of organizational commitment, communication climate and CMC use on knowledge sharing. *Journal of Knowledge Management, 8*(6), 117-130.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing, 68*(1), 1-17.

Vivas López, S. (2005). Competitive advantage and strategy formulation: The key role of dynamic capabilities. *Management Decision, 43*(5), 661-669.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.

Wilden, R., Gudergan, S. P., Nielsen, B. B., & Lings, I. (2013). Dynamic capabilities and performance: strategy, structure and environment. *Long Range Planning, 46*(1), 72-96.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal, 24*(10), 991-995.

Wu, S. J., Melnyk, S. A., & Flynn, B. B. (2010). Operational capabilities: The secret ingredient. *Decision Sciences, 41*(4), 721-754.

Wüstenhagen, R., Sharma, S., Starik, M., & Wuebker, R. (2008). Sustainability, innovation and entrepreneurship: introduction to the volume. *Sustainable Innovation and Entrepreneurship,* 1-23.

Zacharia, Z. G., Nix, N. W., & Lusch, R. F. (2011). Capabilities that enhance outcomes of an episodic supply chain collaboration. *Journal of Operation Management, 29*, 591-603.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185-203.

Zahra, S. A., Sapienza, H. J., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: a review, model and research agenda. *Journal of Management Studies, 43*(4), 917-955.

Zander, U., & Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization Science, 6*(1), 76-92.

Zhou, K. Z., & Li, C. B. (2012). How knowledge affects radical innovation: Knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal*, *33*(9), 1090-1102.

Zhou, K. Z., & Wu, F. (2010). Technological capability, strategic flexibility, and product innovation. *Strategic Management Journal*, *31*(5), 547-561.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science, 13*(3), 339-351.

Zott, C. (2003). Dynamic capabilities and the emergence of intraindustry differential firm performance: insights from a simulation study. *Strategic Management Journal*, *24*(2), 97-125.

CHAPTER 3

The What, Who, When, Where and How of green innovation research: A bibliometric analysis

CHAPTER 3: The What, Who, When, Where and How of green innovation research: A bibliometric analysis

Abstract:

The topic of green innovation (GI) has increasingly reached organizational relevance due to its contribution to the satisfaction of environmental needs at the same time that allows companies to differentiate themselves from their competitors and hence, attain sustainable competitive advantages. In this context, we conducted a detailed analysis of 618 papers on green innovation from the Web of Science (WoS) database for the 1971–2016 stage. This paper develops a bibliometric analysis with the aim of evaluating the key papers in the field and recognizing the most substantive contributions in the literature. This study brings the following findings (i) the number of publications; (ii) the journal with the main number of articles is *Technological Forecasting and Social Change* and *Business Strategy and the Environment*; (iii) the countries with more publications are USA, China and UK; (iv) the most prolific authors on the topic are Yu-Shan Chen, Ching-Hsun Chang and Sarkis Joseph; (v) the antecedent variables acting as key drivers of GI in these studies include: environmental regulations, environmental normative levels, environmental leadership, environmental culture, stakeholders' environmental request, relationship learning, knowledge sharing and information technology; (vi) the research trends and popular issues in this field of study are innovation, green innovation, sustainability, sustainable development, and environment, among others; (vii) the main outcomes of GI are environmental performance, financial performance, competitive advantages, green image and customer capital. Besides, the main scientific gaps on this topic involve the regulatory stakeholders, community stakeholders, organisational support and government support. Therefore, this paper provides critical information for evaluating the productivity, impact and research performance of journals, countries, research institutions and authors, serving as orientation and guide for researchers who are new in the green innovation topic, and enhancing their knowledge about which journals, authors and articles may consult while creating their theoretical framework.

Keywords: Green Innovation, Sustainability, Bibliometric Analysis, Web of Science

1. Introduction

In recent years, the growing global concern about environmental issues, the strict regulations on the international conventions for sustainability and environmental protection, and the increase of the known as pro-environmental consumers have led industries to making a significant endeavor to develop green practices. However, until a few years ago, the academic community had not paid much attention to the organizations' role in protecting the environment.

In this way, and despite many researchers' recent attempts to understand and explain this topic, the green innovation (GI) construct remains open to interpretation concerning even its most necessary aspects, including the definitions or types of innovation and measurement. This ambiguity has led to a significant escalation in the number of working papers, conference sessions, and workshops on GI throughout the world. Special issues focused on GI are beginning to emerge in academic books and journals. The wide variety of studies contributes to the vitality and affluence of research on GI but also to certain confusion regarding the construct's meaning and utility. Several studies bring insights from a literature review on GI (i.e., Schiederig Tietzer, Herstatt, 2012; Chen Chang, & Wu, 2012); however, the field of GI is starting to split into different branches because of researchers' different focus of study.

Recently, some studies have applied the bibliometric methodology in the field of eco innovation (i.e., Díaz-García González-Moreno, & Sáez-Martínez, 2015). However, these studies rely only on the use of such methodology to complement a theoretical article with graphs and tables showing the distribution of the papers per year or the group of journals involving a certain degree of specialization on the topic.

By contrast, this research applies bibliometric methods to search the way in which the scholarly literature on GI is being developed. The bibliometric methodology allows giving shape, structure and direction to the research domain as it develops and progress. Hence, the aim of this study is to use the bibliometric methodology in the field to analyze the existing academic research on GI and to identify possible directions of research.

Through a bibliometric analysis we examine key indicators as for example the number of studies published, the most productive and prolific authors, the most productive and influential countries, the journals that devote more attention to publishing issues referred to this particular topic, or the most cited empirical studies and the research trends and popular issues in this field of study.

This study could guide researchers through the concept of GI in that it shows which literature must be included in further analyses. Furthermore, this study might serve as a reference and preliminary approach for new researchers aiming to become familiarized with the literature and trends on GI.

The study uses the Web of Science record, which presents up to 2350 publications until the end of 2015. However, this study focuses exclusively on analyzing the publications related to the topic of green innovation within the business economics research area from 1971 to 2015, in order to assess their scholarly impact. This period of time comprises 618 publications devoted to investigating GI.

The objectives of this paper are: 1) identify the critical literature about this topic based on the publication impact or scholar community; 2) clarify the most productive journals; 3) assess the authors more productive and relevant; 4) know the countries in which have been published more on green innovation; 5) identify the most cited papers about this topic; 6)bring to light the main concerns or debate more important on this topic; and 7) provide future publishing strategies on this topic or review the last empirical paper of the area to offer future research gaps.

The structure of this work is as follows. The second section presents a evaluation of the GI literature to show the impact of this topic on the management field and delimitate its domain. In the third section, this study describes the method. The fourth section shows the results of the bibliometric analysis. And finally, the fifth section presents the conclusions, limitations and possible directions for future studies.

2. A review of the green innovation concept

In light of our objectives we will now review the term of green innovation because there are different terms to define them. In general, four different terms are used to explain that type of innovation aiming at minimizing the negative effect that organizations exert upon the environment, “eco”, “sustainable”, “environmental”, and “green” (Hashim, Bock & Cooper, 2015). These concepts have several differentiations and similarities among them. Subsequently, we briefly review some of the most accurate definitions in this regard.

According to Kemp and Pearson (2007) the term "eco-innovation" consists in constructing, assimilating, or exploiting a product, service, production process, or managerial method that is novel to the organization (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution, and other negative impacts of the use of resources (including energy use) compared to relevant alternatives. Besides, "environmental innovation" consists of a set of techniques, systems, products and/or new or modified processes that serve to prevent or reduce environmental damage (Kemp, Arundel, & Smith, 2001). Finally, "sustainable innovation" is also defined as "the integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and well-being of all people" (Dresner, 2008, p. 30).

The term "environmental innovation" is revealed as the predominant term. This term is frequently replaced by "eco-innovation," which has been the most commonly used in the last decade (Díaz-García et al., 2015). However, in last year's scholars have focused on the term "green innovation," which is the least developed because of the scarcity of clear and precise definitions in the literature; hence, a clarification of this concept is strongly demanded (Díaz-García et al., 2015). According to Schiederig et al. (2012), the increase in the use of the different terms depends on the aspects of different definitions (i.e., innovation object, market orientation, phase, impulse or level).

Although several authors such as Porter and Van der Linde (1995), Chen, Lai, & Wen (2006), Chang (2011), Aguilera-Caracuel and Ortiz-de-Mandojana (2013) among others have previously defined green innovation, a clarification of the concept is necessary for the aim of this study.

We initially define the concept of green innovation (GI) as a type of innovation whose main objective is to diminish or avoid environmental problems while enabling companies to gratify new consumer demands, create value, and increase yields, and protecting the environment.

Some previous references to the concept can be found in the literature. Authors like Porter and Van der Linde (1995) or Hart (1995) suggest that GI may increase firms' productivity and maximize their use of resources becoming hence more competitive due to the gain and sustainment of competitive advantages rooted in the corporate image improvement and the development of new markets while satisfying the condition of environmental protection (Lai et al., 2003, Chang, 2011). However, it is after the publication of a seminal article on green innovation by Chen, Lai and Wen, (2006) that a growing flow of research was generated with regard to this particular topic. It is the first time that a clear concept of green innovation appears. Chen et al. (2006, p. 332) explain the term "green innovation" as "hardware or software innovation that 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". In their efforts to carry out environmental actions, companies might develop new products, processes, and/or managerial innovations that are designed to rise companies' levels of efficacy and/or efficiency (Gluch et al., 2009). These authors also suggest that green innovation is involved in waste recycling, green product designs, energy saving, pollution prevention, and corporate environmental management.

Chang (2011, p. 363) states that green innovation "can enhance the performance of environmental management to satisfy the requirements of environmental protection. A company devotes to develop green innovation cannot only meet the environmental regulations, but also build up the barriers to the other competitors". Leenders and Chandra (2013) argue that green innovation is a product or process innovation that includes the development of new technologies focused on pollution prevention, waste recycling, energy saving, and eco-efficient design. Recently, Hashim et al., (2015) posited that this kind of innovation seeks to reduce the effect of the firm's activity on the environment by including transformations in corporate strategies, product-designing methods, production processes, resource consumption, and waste disposal procedures.

Thus, green innovation is sustained to exert a positive effect on competitive advantage (Porter and Van der Linde, 1995; Klassen and Whybank, 1999; Chen, et al., 2006). If the companies are ready to carry out green innovations, they might capture the advantages of differentiation and challenge the existing competitive rules. Green innovation has become a core strategic concern for firms, which may be described as a combination of abilities and knowledge that allows to generate commercial innovations without harming the environment (Leal-Millán, Roldan et al., 2016) at the same time that advance their corporate image. Hence, the companies would commercialize sustainable products—protection of the environment in the design and package products—that might increase the differentiation advantages (Chen et al., 2006; Hart, 1995). Moreover, the adoption of environment-oriented managerial proactive strategies will allow firms to prevent facing sanctions or environmentalists' protests (Henriques and Sadorsky, 1999). The pioneers in implementing green innovation can sell green products and services at higher prices, enjoying higher profits, improving their corporate image, selling their innovative environmental technologies, and even creating new markets (Porter and Van der Linde, 1995) that address the needs of the most demanding customers. In this way, green innovation increases the companies' productivity and efficiency at assigning resources and their environmental management performance, in order to meet the requirements of environmental protection (Lai et al., 2003), at the same time that creates while creating barriers to competitors (Barney, 1991). Next, table 1 shows the green innovation definition focus.

Table 1. Green innovation definition focus

Author	Focus
Walley and Whitehead (1994)	Continuous innovation, new market opportunities, wealth creation.
Hart (1995)	Quality of life, very profitable, not only in terms of efficiency.
Porter and van der Linde (1995)	Corporate image, successful companies.
Driessen and Hillebrand (2002)	Environmental burden.
Noci and Verganti (1999)	Concerns not only the process but also the product.
Lai, Wen and Chen (2003)	Environmental management, requirement of environmental protection.
Chen, Lai and Wen (2006)	Hardware or software innovation, green products or processes, innovation in technologies, energy saving, pollution prevention, waste recycling, green product designs, corporate environmental management.
Chen (2008)	Environmental management, environmental protection, corporate images, develop new markets, competitive advantages.
Chang (2011)	Satisfy the requirements of environmental protection, devoted to developing green innovation, environmental regulations, barriers to other competitors.
Chen, Chang and Wu (2012)	Enhance product value, offset the costs of environmental investments.
Tseng, Huang and Chiu (2012)	Minimisation of environmental impacts, management innovation, process innovation, product innovation, technological innovation.
Aguilera-Caracuel and Ortiz-de-Mandojana (2013)	Technological improvements, save energy, prevent pollution, waste recycling, green product design, corporate environmental management.
Leender and Chandra (2013)	Development of new technologies, energy saving, pollution prevention, waste recycling, eco-efficient design.
Hashim, Bock and Cooper (2015)	Type of innovation reduced impact on the environment.
Leal-Millán, Roldán, Leal-Rodríguez and Ortega-Gutiérrez (2016)	Strategic need for firms, great opportunity to meet buyers' harming the environment.
Albort-Morant et al., (2016)	Mitigate or avoid environmental damage responsible and optimal use of available resources.

3. Method

In order to develop the objectives that we have explained in the introduction use the Bibliometric analysis. This technique was introduced by Garfield (1955), who claimed that it collects a set of mathematical methods and statistics that are used to analyze and measure publications (i.e., articles, books, book chapters among others). It consists in applying statistical methods to establish qualitative and quantitative changes within a given scientific research topic, to detect the profile of publications on the topic, and to find tendencies within a discipline (De Bakker et al., 2005; Bouyssou and Marchant, 2011; Saatçioğlu et al., 2016). Bibliometric analyses examine bibliographical material that is useful to exploit, organize and analyze the information in a particular field (Merigó et al., 2015) for experts looking for to assess scientific activity (Duque-Oliva et al., 2006). It represents an innovative methodology with respect to traditional theoretical framework building (Bjork et al., 2014). Hence, bibliometric analyses will allow knowing the past, understanding the advances of the investigations and enhancing future researches. The resulting information also helps in decision-making (Durieux and Gevenois, 2010).

Finally, for illustrate our study we use two software tools, *Bibexcel* is frequently used as a research tool for perform bibliometric and network analysis (Persson, Danell and Schneider, 2009), and the mapping is conducted using the Pajek program that isused for the study and imagining of large networks (Batagelj and Mrvar, 2003). The two softwares are link since Bibexcel is a versatile bibliometric tool that allows easy relations with other software as Pajek, Excel or SPSS. These software are very useful for the type of study that we are going to realized below.

3.1. Choice of database

The first step of a bibliometric analysis consists in identifying the databases that would be useful for the research purposes. The bibliometric analysis is limited by the available information; therefore, the information sources must be reliable and suitable to perform the analysis and to take the best decisions (Rueda et al., 2007); hence the importance of choosing an appropriate database. The ISI, Scopus and Google Scholar databases are available and updated, and so their use in the literature is very frequent.

This study uses the Thomson Reuters Web of Science database (WoS), formerly ISI Web of Knowledge, which is an online systematic information supporter. This catalog provides scholars access to material available from scientific journals, books, and other academic papers in all fields of science. All journals in the Thomson Reuters Web of Science have an impact factor in the *Journal Citation Report* (JCR), which enables classifying journals in top tier or lower journals according. The bibliometric analysis of studies within the WoS allows providing data on output, collaboration, dissemination, and impacting (De Bakker et al., 2005).

3.2. Indicators

After choosing the database, the second step is to choose the indicators to evaluate the sample obtained. Few studies provide a description of the methodology that should be applied for a bibliometric analysis (the appropriate indicators, their measurement, and their graph representation or their interpretation) (Van Raan, 2005). As a result, the literature presents different types of bibliometric indicators (Durieux and Gevenois (2010); Cadavid-Higuita et al., (2012)). According to Durieux and Gevenois (2010) three types of bibliometric indicators exist: 1) quantity (amount the productivity), 2) quality (measure the impact), and 3) structural (measure the connections) indicators.

This analysis relies on the use of two kinds of bibliometric indicators: a quantity indicator and a quality indicator. The first indicator allows to measure the production of an researcher in terms of number of publications, and the second indicator measures the frequency with which a publication, author or a journal, are cited by other publications (number of citations) (Cadavid-Higuita et al., 2012). These indicators allow studying the extent to which the attention on green innovation has grown in current years.

This study also includes the *Hirsch index* or *h-index* indicator (Hirsch, 2005). This indicator captures both the quantity and the visibility of authors' published studies (Egghe, 2006; Van Raan, 2006) indicating the numbers of publications (X) that have received X number of citations (both X are the same number). For example: a h-index of 7 means that a scientist has published 7 articles that have received at least 7 citations each.

And finally, the study also carried out a structural indicator (network analysis) to clarify the relations among different trends and topics by underlying a network of nodes and relations through which information or social relationship travel. In this study network analysis is conducted in order to establish a network with the nodes that represent topics and trends. A network can help analyze the status and impact of a node by measuring the centrality of the nodes (Gao, et al., 2006). The programs implemented for examination and picturing of large networks are Bibexcel and Pajek.

3.3. Codification process

This study examines the research area of business economics, which comprises more studies on green innovation than other areas (618 research studies). Our analysis was performed in January 2016, using the WoS database. This study analyzes scientific studies for the period 1971-2015. The starting year is 1971, the date of publication of the first study on green innovation listed in the WoS.

This bibliometric analysis includes the most common knowledge areas, the most prolific authors, the journals with most publications, the most productive countries and the most cited studies. The search term used is “green innovation” and the results were filtered according to the indicators used. The webpage of Web of Science allows to filter the results, as well as, to collect the publications using the key word "green innovation" in titles, in abstract and/or keywords.

4. Results

This section shows the results of the bibliometric analysis on green innovation. Given that the purpose of this work is to gain an overall viewpoint of the development of research on green innovation, the analysis is not limited to any specific language, document type, or country. This study examines research works published between 1971 and 2015. The study titled *Elements of induced innovation-Historical perspective for green revolution* by Yujiero Hayami (1971) was the first document published on the topic in the WoS.

The 618 studies on green innovation in the business economics field comprise 383 articles, 200 proceedings papers, 14 reviews, 2 editorial materials, 3 book reviews, and 1 note, reprint, and discussion.

The bibliometric variables applied in this study are presented as follows:

- The number of publications on green innovation per year between 1971 and 2015.
- Most productive journals that have published research on green innovation.
- Authors with the greatest productivity on green innovation.
- Countries with the highest rate of productivity on green innovation.
- The most cited papers published on green innovation.
- The research trends and popular topics
- The number of empirical studies that assess the green innovation variable.

4.1. Evolution of publications and citations structure on green innovation

Figure 1 presents the accumulation of the number of studies published about green innovation since 1971 and reveals the existence of three stages in the publication trend. The first stage corresponds to the period between 1971 and 1999, when the volume of studies was under 20 studies per year. The second stage covers the period from 2000 to 2007, when research grows moderately. The annual volume was of 19 studies. Finally, during the third stage, from 2008 to 2015, the number of publications increases considerably. The annual volume for this period has been between 60-90 studies, reaching a record of 92 in 2015. Figure 1 also reveals the number of citations per year reached by these studies.

Table 2 shows the annual number of citations corresponding to green innovation studies. The results show that, during the last years, the increase of citations has been more significant, gaining a record of 1282 citations in 2010. The high number of citations corresponding to the year 1997 (1012) owes to the publication of "*A resource-based perspective on corporate environmental performance and profitability*" by Russo and Fouts (1997), which holds by itself up to 943 cites. This article has the highest number of citations on green innovation. Similarly, out of the 1165 citations of the year

2000, 582 citations belong to one article entitled "*Why companies go green: A model of ecological responsiveness*" written by Bansal and Roth (2000).

Additionally, Table 2 provides the results for the number of articles that have 100 or more, 50 or more, and 20 or more citations. that the results show that only 16.16% of the studies obtain more than 100 citations, 25.38% obtain more than 50, 61.50% more than 20, almost 57.59% more than 10, 65.40% more than 5 citations, and the rest of the studies received more than 1 citation.

In last decades, we observe a significant growth in the number of publications. The information and communication technologies (ICTs) might have enabled this increase, as they have facilitated the introduction of bibliographic reference tools and online databases (i.e. Scopus or Web of Science).

Figure 1. Display of total publications (accumulated) and total citations on green innovation between 1971 and 2015

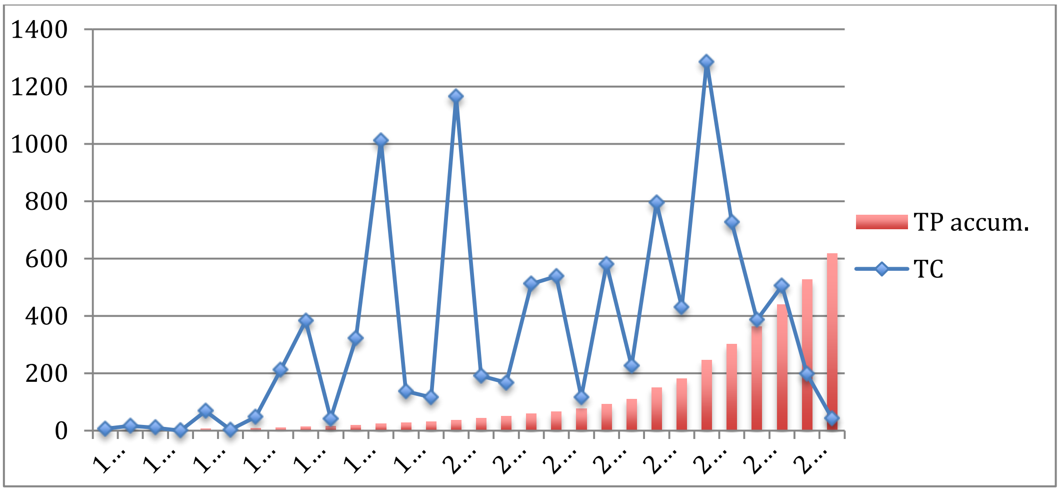


Table 2. General citation structure of green innovation literature according to WOS

Year	Total Studies	Total Citations	>100	>50	>20	>10	>5	>1
1971	1	6	0	0	0	0	1	0
1981	2	17	0	0	0	1	0	1
1987	1	10	0	0	0	1	0	0
1989	1	0	0	0	0	0	0	0
1990	1	68	0	1	0	0	0	0
1991	1	3	0	0	0	0	0	1

1992	1	48	0	0	1	0	0	0
1993	1	212	1	0	0	0	0	0
1994	4	383	1	0	1	0	0	2
1995	2	42	0	0	1	1	0	0
1996	4	322	1	2	0	0	0	1
1997	4	1012	1	0	0	1	1	0
1998	4	137	0	1	1	1	1	0
1999	3	116	0	1	1	0	0	0
2000	6	1165	2	0	1	0	0	0
2001	7	191	1	0	1	3	2	0
2002	7	167	0	1	4	1	1	0
2003	9	512	1	3	3	0	1	0
2004	6	539	1	0	3	1	0	0
2005	11	117	0	1	0	1	1	1
2006	15	580	2	1	3	1	1	1
2007	19	226	1	0	1	3	1	2
2008	40	795	1	7	2	5	3	2
2009	31	431	0	2	7	3	4	2
2010	65	1286	4	4	7	3	6	7
2011	55	727	0	2	13	10	10	1
2012	61	386	0	0	4	10	11	15
2013	77	505	0	0	7	12	19	20
2014	87	198	0	0	2	0	4	10
2015	92	43	0	0	0	1	0	21
Total	618	10244	17	26	63	59	67	87
Percentage	100%	100%	16,60%	25,38%	61,50%	57,59%	65,40%	84,93%

4.2. The most productive and influential journals on green innovation

This study identifies 109 scientific journals belonging to the business economics area (management, business, and economics) which are indexed in Thomson Reuters Journal Citation Report (JCR), and publish studies on green innovation. Table 3 shows the 20 most dynamic and relevant journals in terms of number of publications in this field of research, jointly with their country, number of publications, impact factor, and their JCR category and quartile.

Three journals are especially significant: (i) *Technological Foresting and Social* Change, with 24 publications (TP) on green innovation, (ii) Business Strategy and the Environment, with 23 publications, and (iii) Ecological Economics, with 20 documents. These journals have published more research in this field than any other journal.

The impact factor of the journals denotes to the information enclosed in the Journal Citation Reports (JCR) with regard to the Science Citation Index (SCI). It delivers scholars with an objective weigh of the influence of different journals within a particular category. In this case, the journal with the highest JCR impact factor (2014) is Supply Chain Management an International Journal, with a score of 3.500 points, followed by Research Policy, with an impact factor of 3.117 points. Finally, the journal Ecological Economics ranks third with 2.720 points.

Table 3 presents the category of these journals in the JCR index. Quartiles are a way to measure the journal's importance as compared to other journals. To calculate the quartiles, this index divides the total number of journals into four groups, corresponding to the four quartiles. Journals inside the first quartile are the most significant, while journals in the last quartile would be those with the lowest impact factor. Given that the top 20 journals on green innovation are within the first and second quartiles, most of the journals appearing in the list below have a relatively high impact factor.

With regard to the country, most of the scientific journals covering research on the green innovation topic are from England (8 journals), USA (6 journals), and The Netherlands (4 journals).

Table 3. Scientific journals with more studies on green innovation

Rank	Journal	Country	TP	Impact Factor 2014	JCR Category and quartile
1	Technological Forecasting and Social Change	USA	24	2.058	Business: Q1; Planning and Development: Q1
2	Business Strategy and the Environment	USA	23	2.542	Business:Q1; Environmental Studies: Q1; Management: Q1
3	Ecological Economics	Netherlands	20	2.720	Ecology: Q2; Economics: Q1; Environmental Sciences: Q2;

					Environmental Studies: Q1
4	Journal of Business Ethics	Netherlands	20	1.326	Business: Q3; Ethics:Q1
5	Research Policy	Netherlands	19	3.117	Management: Q1; Plannings and Development: Q1
6	Technology Analysis Strategic Management	England	16	0.942	Management: Q1
7	Environmental Resource Economics	USA	8	1.426	Economics: Q1; Emvironmental Studies: Q3
8	Management Decision	England	8	1.429	Business: Q2; Management: Q2
9	Energy Economics	Netherlands	7	1.965	Economics: Q1
10	International Journal of Operations Production Management	England	7	1.736	Management: Q2
11	Organization and Environment	USA	7	1.036	Environmental Studies: Q2; Management: Q2
12	World Development	England	7	1.965	Economics: Q1; Plannings and Development: Q1
13	African Journal of Business Management	Nigeria	6	1.11	Business: Q3; Management: Q3
14	Asian Journal of Technology Innovation	England	6	0.308	Business: Q4; Economics: Q4
15	R&D Management	England	6	0.848	Business: Q3; Management: Q3
16	Supply Chain Management an International Journal	England	6	3.500	Business: Q1; Management: Q1
17	Industrial Marketing Management	USA	5	1.820	Business: Q2; Management: Q2
18	Innovation Management Policy & Practice	Australia	5	0.38	Management: Q4
19	Journal of Product Innovation Management	USA	5	1.696	Business: Q2; Engineering Industrial: Q2; Management: Q2

20	Oxford Review of Economic Policy	England	5	1.042	Economics: Q2

4.3. Influential authors and institutions on green innovation

Table 4 presents a striped of the 20 authors with the highest number of articles on green innovation, together with their university/institution and the country where the author is employed at the moment. We argue that for researchers that are beginning to carry out studies in the field of green innovation it might be advisable to work with experts or researchers that are already well established in it (Araoz, 2014). We observe that many authors from a wide range of origins have carried out research on green innovation and published in journals indexed in the WoS. The rank includes the total number of publications (TP), the total number of citations (TC), average citations per study (C/S), and finally, the h-index used to measure the quality of the research output on the number of citations received.

The number of studies published measures the author's productivity and the number of citations received measures the author's impact. Hence, providing a combined viewpoint—productivity and influence—gives more information. Therefore, the most prolific authors on the topic are Yu-Shan Chen, Ching-Hsun Chang, and Joseph Sarkis with 10, 8, and 6 studies respectively. Nevertheless, the author with higher number of citations is Sarkis, with 508. In spite of having more publications, Chen and Chang are not the most influential authors. In the case of citations per study, Sarkis has 84.6 citations per study and Devashish Pujari has 62 citations per study, being the authors with more citations per study. However, this database only counts the citations of publications listed in the WOS. Therefore, these authors may have more citations that are not accounted for in this study.

Regarding relevant institutions, the institution with more top authors affiliated is the University of Ferrara (Italy) (three authors), and the National Central University (Taiwan) (two authors). The presence in the ranking of Italian and Taiwanese authors, which also belong to non-English speaking institutions, is remarkable. Table 4 illustrations the h-index, which assesses a researcher's productivity. The author with the highest h-index is Chen (h=7) followed by Ching-Hsun Chang (h=5) and Joseph Sarkis (h=5).

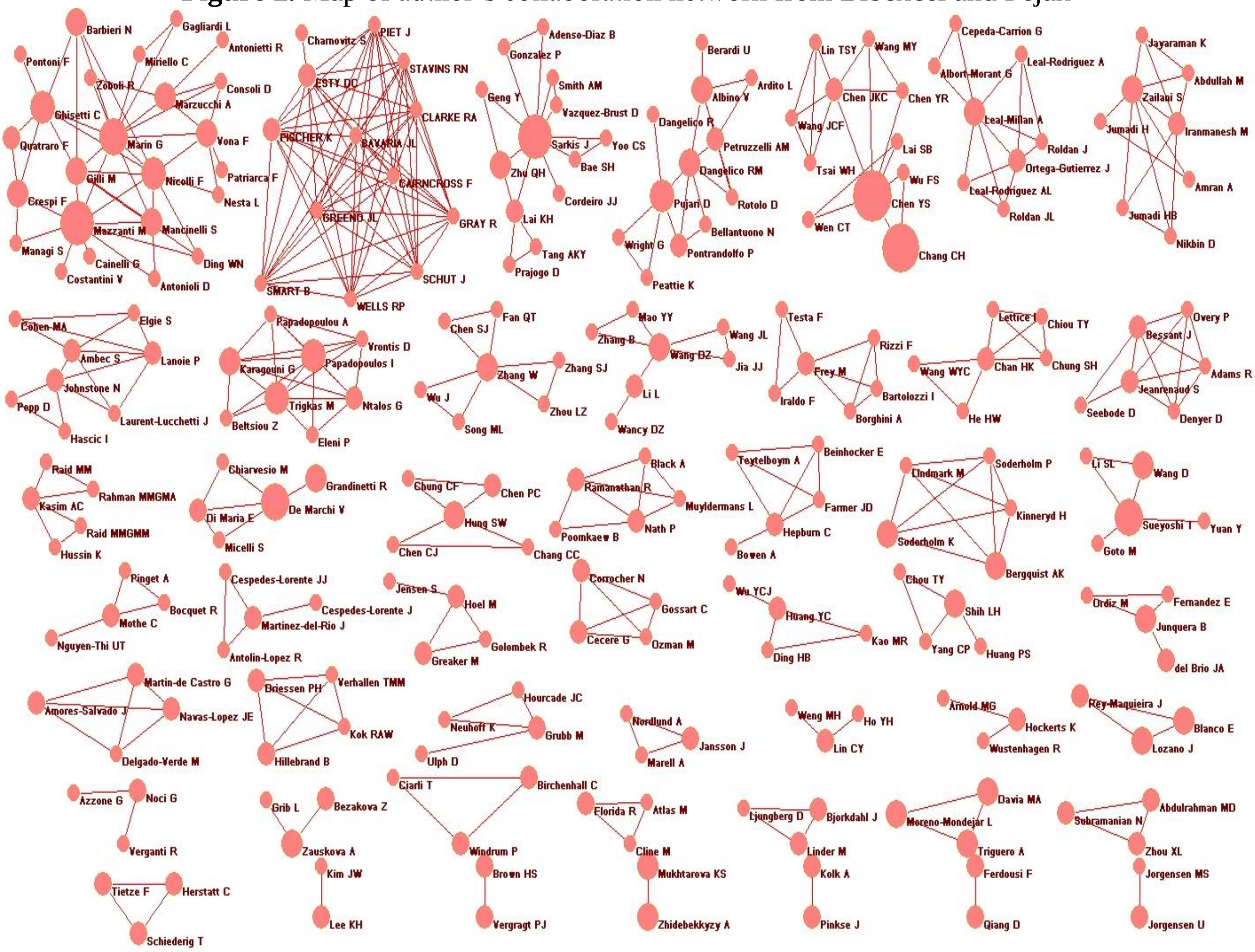
Table 4. The most important authors and institutions on green innovation research

Rank	Author	University	Country	TP	TC	C/S	H-index
1	Chen, Yu-Shan	Atl Taipei Univ.	Taiwan	10	384	38.4	7
2	Chang, Ching-Hsun	I Shou Univ.	Taiwan	8	77	9.62	5
3	Sarkis, Joseph	Worcester Polytech Inst.	USA	6	508	84.6	5
4	Mazzanti, Massimiliano	Univ. Ferrara	Italy	5	66	13.2	3
5	De Marchi, Valentina	Univ. Padua	Italy	4	13	3.25	2
6	Pujari,Devashish	McMaster Univ.	Canada	4	248	62	4
7	Sueyoshi, Toshiyuki	New Mexico Inst Min & Technol	USA	4	33	8.25	4
8	Wagner, Marcus	Univ. Wurzburg	Germany	4	90	22.5	4
9	Bergquist, Ann-Kristin	Umea Univ.	Sweden	3	16	5.35	2
10	Blanco, Esther	Univ. Innsbruck	Austria	3	46	15.33	2
11	Cooke, Philip	Cardiff Univ.	Wales	3	30	10	2
12	Dangelico, Rosa Maria	Univ. Roma La Sapienza	Italy	3	18	6	2
13	Ghisetti, Claudia	Univ. Ferrara	Italy	3	9	3	1
14	Grandinetti, Roberto	Univ. Padua	Italy	3	3	1	1
15	Hung, Shiu-Wan	Natl Cent Univ.	Taiwan	3	8	2.67	1
16	Junquera, Beatriz	Univ. Oviedo	Spain	3	104	34.6	2
17	Lozano, Josep	Univ. Balearic Isl	Spain	3	46	15.3	2
18	Mancinelli, Susanna	Univ. Ferrara	Italy	3	16	5.33	1
19	Shih, Li-Hsing	Natl Cheng Kung Univ.	Taiwan	3	4	1.33	1
20	Wang, De-Zhou	Harbin Univ. Commerce	China	3	0	0	0

In figure 2 it can be observed the author's collaboration network. Author's cooperation among different colleagues and research groups is of significance. They can communicate with each other to enhance their understandings and seek innovative solutions to complicate research problems. The size of the nodes of the network (authors) gets progressively increased, being largest nodes those with a much greater amount of publications associated, i.e. it is observed that those authors with major publications quantity tend to publish in large networks (6-10 people), while small networks have to be couples or trios. Within the 48 existing nodes, there are 9 large nodes which include authors who have published a large number of articles on the topic, such as Cheng, Chang, Mazzanti, Pujari or Sarkis.However, the most remarkable community is dominated by Mazzanti, Nicelli or Marin, among others. Besides, the most productive community is shaped by two of the authors with highest number of publications on green innovation, Chen and Chang.

In conclusion, we can observe a large number of nodes because there are not national and international relations between authors. The nodes of the network (authors) are eminently limited to coworkers or colleagues who are researching the same topic. Therefore, many real networks show a focus of links inside of certain clusters of nodes called communities.

Figure 2. Map of author's collaboration network from Bibexcel and Pejak



4.4. Countries with the highest productivity rate

This study analyzes the top 20 countries where the authors produce most research on green innovation. Table 5 shows that the United States of America rank first with 122 publications, which entailed 5234 citations, 42.9 citations per article, and h-index of 27 points. Most of the journals of publication are American, and so authors from USA may enjoy superior access to these journals than authors from other countries. Following the USA, China and England occupy the second and third position with 109 and 58 studies respectively. However, China has a lower volume of citations, citations per article, and h-index than England.

The country with the highest productivity rating (C/P) is Canada, the country with most citations per article, followed by USA and Australia. As for the h-index, the country with the highest h-index is the USA, followed by England and Canada. It should be remarked that Canada has one of the best productivity ratings, with 49.5 citations per article. Although it has only 30 articles, they are of a great quality and thus received more citations per article than many publications from other countries.

Figure 3 presents a world map representing the countries comprising the greater number of publications on the field of green innovation.

Table 5. Top 20 countries with the highest productivity rate

Rank	Country	TP	TC	C/S	h-index
1	USA	122	5234	42.9	27
2	China	109	651	5.97	6
3	England	58	971	16.7	15
4	Taiwan	45	592	13.1	11
5	Italy	42	439	10.4	10
6	Spain	31	277	8.94	8
7	Canada	30	1485	49.5	14
8	France	30	440	14.67	9
9	Germany	29	477	16.4	12
10	Netherlands	22	444	20.1	7
11	Sweden	14	140	10	7
12	Australia	13	359	27.62	5
13	Japan	13	59	4.54	4
14	Romania	13	0	0	0
15	Malaysia	12	1	0.08	1
16	Denmark	11	125	11.3	6
17	South Korea	10	132	13.2	4
18	Wales	8	153	19.1	4
19	Brazil	7	13	1.8	1
20	Slovakia	7	0	0	0

Figure 3. Geographical display of the top 20 countries publishing on green innovation

4.5. The most cited papers published on green innovation

This section presents the 20 most cited studies found in Web of Science (Table 6). Publications were composed expending the search string "green innovation" in abstract, keywords, and/or title, including all published studies within the business economics discipline.

The most cited article, with almost 950 citations is entitled "A resource-based perspective on corporate environmental performance and profitability" and was written by Russo and Fouts (1997). These authors argue that there is a positive relationship between environmental performance and economic performance, and that such link is moderated by industry growth. They carry out a longitudinal analysis to test their hypotheses within a sample of 243 companies. Their results reveal that being green pays off and that that the relation between environmental performance and economic performance boosts in higher-growth industries. In second place, the article entitled "Why companies go green: A model of ecological responsiveness", by Bansal and Roth (2000), has reached 582 citations. This study intended to disentangle the motivations and contextual factors underlying corporate ecological responsiveness. They gathered qualitative data from 53 companies from the United Kingdom and Japan. Their results unveiled three main motivations—competitiveness, legitimation, and ecological responsibility—which are in turn inclined by three contextual conditions—field cohesion, issue salience, and individual concern. A study by Zhu and Sarkis (2004) appears in third place with 393 citations. In this work, the authors investigate how two principal managerial operations philosophies, quality management and just-in-time (or lean) manufacturing, stimulus the relationship between green supply chain management practices and business performance. The first two works were published in the Academy of Management Journal, one of the most relevant and prestigious research journals within the field of management. In the same way, most studies of this list are from the 1990's and 2000s, though some recent studies also appear in the list.

Table 6. The 20 most cited studies on green innovation

Rank	TC	Title	Author/s	Journal
1	943	A resource-based perspective on corporate environmental performance and profitability	Russo & Fouts (1997)	Academy of Management Journal
2	582	Why companies go green: A model of ecological responsiveness	Bansal & Roth (2000)	Academy of Management Journal
3	393	Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises	Zhu & Sarkis (2004)	Journal of Operations Management
4	341	Its not easy being green	Walley & Whitehead (1994)	Harvard Business Review
5	233	Extending green practices across the supply chain - The impact of upstream and downstream integration	Vachon & Klassen (2006)	Intrenational Journal of Operations and Production Management
6	206	The adoption of agricultural innovations-A review	Feder & Umali (1993)	Technological Forecasting and Social Change
7	126	The influence of green innovation performance on corporate advantage in Taiwan	Chen Lai & Wen (2006)	Journal of Business Ethics
8	107	Information systems innovation for environmental sustainability	Melville (2010)	MIS Quartely
9	99	Design for the environment: A quality-based model for green product	Chen (2001)	Management Science

		development		
10	92	Use the supply relationship to develop lean and green suppliers	Simpson & Power (2005)	Supply Chain Management- An International Journal
11	90	Green and competitive - Influences on environmental new product development performance	Pujari, Wright & Peattie (2003)	Journal of Business Ethics
12	88	Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives	Lee (2008)	Supply Chain Management- An International Journal
13	85	The driver of green innovation and green image - Green core competence	Chen (2008)	Journal of Business Ethics
14	79	Managing 'green' product innovation in small firms	Noci & Verganti (1999)	R&D Management
15	75	The Drivers of Green Brand Equity: Green Brand Image, Green Satisfaction, and Green Trust	Chen (2010)	Journal of Business Ethics
16	69	Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability	Dangelico & Pujari, (2010)	Journal of Business Ethics
17	59	The effects of customer benefit and regulation on environmental product innovation. Empirical evidence from appliance manufacturers in Germany	Kammerer (2009)	Ecological Economics
18	56	The positive effect of green intellectual capital on competitive advantages of firms	Chen (2008)	Journal of Business Ethics
19	53	The influence of greening the suppliers and greeninnovation on environmental performance and competitive advantage	Chiou, Chan, Lettice & Chung (2011)	Transportation Research Part E-Logistics and Transportation Review

		in Taiwan		
20	48	Why and how to adopt green management into business organizations? The case of Korean SMES in manufacturing industry	Lee (2009)	Management Decision

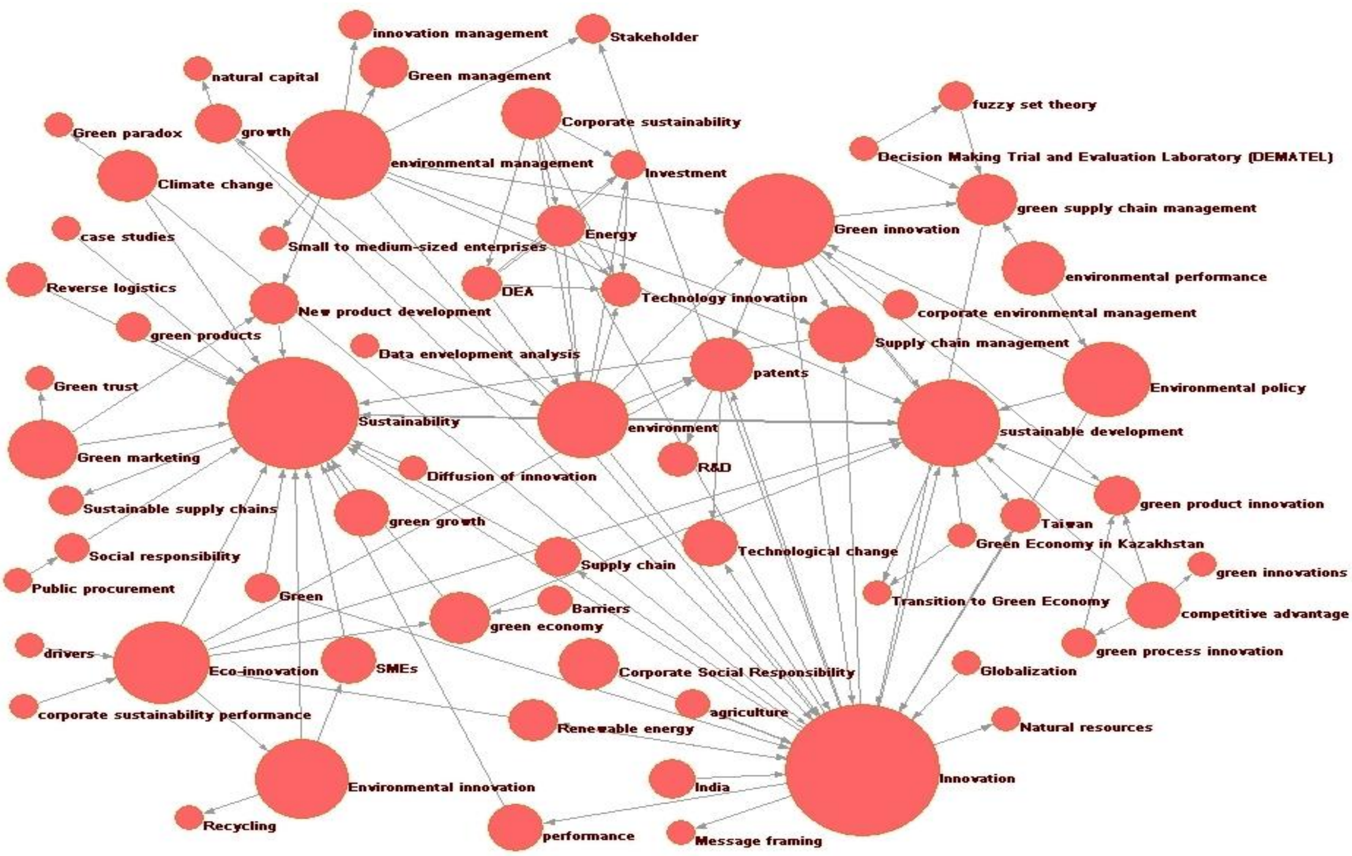
4.6. Research trends and popular issues

In this section, as shown in figure 4, which includes the most frequent topics addressed within this field, we can observe that there exist some certainly large nodes that represent the main terms or topics that shape this field: innovation, sustainability, sustainable development, environmental, and green innovation.

Innovation is the most used term, since it is the key concept from which most researchers within the topic of green innovation begin their work. The subsequent most highlighted nodes are sustainability, sustainable development, and green innovation. Likewise, innovation practices toward sustainable growth have received an increased attention during the last decades. Nonetheless these terms had gone adapting because it did not exist a clear definitions to describe these topics.

We may also pay attention to some topics that are arising and increasingly attaining more attention, although the sizes of their nodes are not that large yet. This is the case of topics such as green marketing, green supply chain management, corporate sustainability, energy and climate change.

Figure 4. Most frequent topic words from Bibexcel and Pejak



4.7. Green innovation as an antecedent or outcome variable: A systematic synthesis of the recent empirical literature

Finally, this section presents a list of empirical studies that use the green innovation variable in their models (Table 7). This list provides the variables most commonly related to green innovation and suggest where to find a theoretical or empirical gap in this research field. Nevertheless, an important proportion of the most cited articles in this field involve theoretical works aimed at the conceptualisation and development of green innovation. In this sense, only 14 studies make empirical use of the green innovation variable. This may be since research in green innovation is still in its initial stages or because there are different and interchangeable terms to refer to the same topic. Table 7 provides the authors' names, the journal title and the variables used in each study. We assess and distinguish between the type of variable to acknowledge which role is associated with green innovation: green innovation drivers (modelling GI as a dependent variable), outcomes of GI (modelling GI as an independent variable) and the mediating or control variable. We did not find moderating variables in these works.

In this section, we also group these studies according to the classification that Díaz-García et al. (2015) previously used and validated. For it, we have read the different works and analyse the variables of these studies. This classification provides the trends in research. The authors cluster the works according to the following categories:

- *Performance*: This category includes articles focusing on the results and outcomes of green innovation: performance, customer capital, competitive advantage etc.
- *Drivers*: The main interest of the articles in this category is finding the antecedents of green innovation.
- *Types*: This category is shaped by articles aimed at classifying the different types of green innovation: product, process, managerial and technological.
- *Process*: This category encompasses all the articles that focus on the process of development of this type of innovations: green supply chain, green marketing, and green technology innovation.
- *Context*: This category comprises articles that focus on showing the special issues occurring in the context of a study such as specific region or country, transition economies etc. These works tend to be comparisons.
- *Policy*: This category groups together the articles that focus on policy evaluation, transition management and the diffusion of green innovation through policies.

With regard to the classification of trends in this research, “performance” and “drivers” are the most recurrent categories. On the one hand, the independent variables that act as drivers of green innovation in these 14 studies include environmental regulations, environmental normative levels, environmental culture, environmental leadership, environmental capability, environmental request of stakeholders, foreign customers and investors, relationship learning, knowledge sharing, organisational support and information technology. On the other hand, the main outcomes of green innovation are environmental performance, financial performance, environmental outcome, competitive advantages, green image and customer capital. Some repeatedly used variables are factors of environmental uncertainty, performance and competitive advantage.

Table 7. Selected empirical research on green innovation

Authors	Journal	Trends in Research	Drivers of Green Innovation	Outcomes of Green Innovation	Mediating or Control Variables
Chen, Lai and Wen (2006)	*Journal of Business Ethics*	Performance		Corporate competitive advantage	
Aguila-Caracuel and Ortiz-de-Mandojana (2013)	*Organization and Environmental*	Performance/ drivers	Environmental regulations, environmental normative levels	Financial performance	
Chen, Chang and Wu (2012)	*Management Decision*	Drivers	Environmental leadership, environmental culture, environmental capability, environmental request of investors and clients, environmental regulations		
Qi et al., (2013)	*Corporate Social Responsibility and Environmental Management*	Drivers	Foreign customers, stockholders, foreign investors, regulatory stakeholders, Community stakeholders		Industrial type, firm size
Wu (2016)	*Supply Chain Management: An International Journal*	Process/drivers	Green supply chain integration		Environmental uncertainty/ firm size
Chang and Chen (2013)	*Management Decision*	Drivers	Green organisational identify		Environmental commitment, environmental organisational legitimacy
Ley, Stucki and Woerter (2016)	*Energy Journal*	Context	Energy prices		
Leal-Millán et al., (2016)	*Journal of Knowledge Management*	Drivers/ performance	Information technology, relationship	Customer capital	

			learning	
Wong (2013)	*Business Strategy and the Environment*	Drivers	green requirements, knowledge sharing	
Chen (2008)	*Journal of Business Ethics*	Drivers/ performance	Green core competences	Green image
Chiou et al., (2011)	*Transportation Research Part E*	Drivers/ performance/ process	Greening the supply	Environmental performance, competitive advantage
Chang (2011)	*Journal of Business Ethics*	Drivers/ performance	Corporate environmental ethics	Competitive advantages
Zaikani et al., (2014)	*Asian Journal of Technology Innovation*	Drivers/ performance/ process	Organisational support, quality of human resources, customer pressure, government support, environmental uncertainty	Environmental outcome

Below, Table 8 shows the level of statistical significance of the variables included in the studies enumerated in Table 8. The level of statistical significance (sig.) may appears with "*"whether it is significant. The number of "*" depends on the t-value of the variable in the hypothesis.

This second table allows deeper and more accurate insights into which of the variables are effectively drivers or outcomes of green innovation.

Given the empirical evidence provided by the examined literature, it has not been demonstrated that regulatory stakeholders, community stakeholders, organisational support and government support constitute drivers of green innovation, as these relationships are found not to be significant. We may highlight that all the other variables (green innovation drivers and outcomes) seem to reach satisfactory levels of statistical significance in their links with green innovation.

Table 8. The level of significance of variables

Authors	GI Drivers	GI Outcomes
Chen, Lai and Wen (2006)		Corporate competitive advantage: +/sig. **

Aguila-Caracuel and Ortiz-de-Mandojana (2013)	Environmental regulations: +/sig. ** Environmental normative levels: +/sig. **	Financial performance: +/sig. *
Chen, Chang and Wu (2012)	Environmental leadership: +/ sig.** Environmental culture: +/ sig.* Environmental capability: +/ sig.* Environmental request of investors and clients: +/ sig.* Environmental regulations: +/ sig.*	
Qi et al., (2013)	Foreign customers: +/ sig. * Stockholders: +/ no sig. Foreign investors: +/ sig. * Regulatory stakeholders: +/ no sig. Community stakeholders: +/ no sig.	
Wu (2016)	Green supply chain integration: +/sig. ***	
Chang and Chen (2013)	Green organisational identify: +/sig. **	
Ley, Stucki and Woerter (2016)	Energy prices: +/sig. **	
Leal-Millán et al., (2016)	Information technology: +/sig. *** Relationship learning: +/sig. ***	Customer capital: +/sig. ***
Wong (2013)	Green requirements: +/sig. * Knowledge sharing: +/sig. ***	
Chen (2008)	Green core competences: +/sig. **	Green image: +/sig. **
Chiou et al., (2011)	Greening the supply: +/sig. ***	Environmental performance: +/sig. *** Competitive advantage: +/sig. ***
Chang (2011)	Corporate environmental: +/sig. **	Competitive advantages: +/sig. *
Zaikani et al., (2014)	Organizational support: +/ no sig. Quality of human resources: +/ sig. *** Customer pressure: +/ sig.* Government support: +/ no sig. Environmental uncertainty: +/ sig. ***	Environmental outcome: +/sig. ***

5. Discussion

This work presents a bibliometric analysis of the literature on GI between 1971 and 2015, according to the publications available in the WoS. Our paper provides a general overview of the recent studies on GI to define the areas within which researchers are learning the topic, the most prolific and influential authors, the most relevant journals for literature review, the productivity by countries, and the empirical studies in this field. Moreover, this study delivers an analysis of the literature and attempts to summarize the available research and findings published so far. In summary, this study suggestions a guide to those who are entering the green innovation field, providing information with regard to which journals to consult, which authors to follow and what articles to read in order to build a worthy literature review on this field.

The results from the bibliometric analysis show 618 green innovation research studies of the specific business economics field gathered from the Web of Science database. Most documents of WoS are articles—1236 general articles of all research fields and 600 specific articles within the business economics field—because this is the format accepted for publication in prestigious research journals.

In the case of GI, the journals with the highest number of articles are Technological Foresting and Social Change (24 articles), Business Strategy and the Environment (23 articles), and Ecological Economics (20 articles). The most popular scientific article on GI is entitled “A resource-based perspective on corporate environmental performance and profitability.” This paper was carried out by Russo and Fouts (1997) and published on Academy of Management Review, one of the most important journals within this field of research.

The most prolific authors within GI are Yu-Shan Chen from the Atlanta Taipei University (Taiwan) with 10 publications, Ching-Hsun Chang from I-Shou University (Taiwan) with 8 publications, and Joseph Sarkis from Worcester Polytechnic Institute (USA) with 6 documents published. The academic production is concentrated in a few countries. The country responsible for the greatest volume of GI research is the USA with 122 published studies.

The analysis shows a scarcity of empirical studies that use GI as one of the variables in their research models and hypotheses. Specifically, only 14 empirical studies in the WoS use GI as a research variable. The analysis of empirical studies has allowed us to identify the variables that are used in the proposed models and act as green innovation drivers and outcomes. On the basis of the conclusions reached by the studies assessed, we can affirm that there is heterogeneity with regard to the variables explored in these works.

Therefore, the variables used enable us to have a clear view of the issues addressed in this field, and we can contribute to generating ideas and knowledge for future research.

In this vein, most publications have used the green innovation variable as a dependent variable, probably because the final objective of the model proposed in most of the studies is to identify the effects of GI on the firms implementing it. The green innovation variable has also been used as a mediator of a relationship: In the study by Chiou et al. (2011), green innovation positively mediates the link between greening the supplier and environmental performance.

Our results also show that research on green innovation is relatively recent and has its roots in a very particular framework of the literature entrenched in the field of environmental management. The topic is of current relevance, and its diffusion takes place mostly in conferences and similar meetings. It seems that publishing studies in a new field is easier because there is still much to discover.

Nevertheless, the interpretation of the results presented and discussed above is subject to several limitations. First, this research is based on a sample of documents published in the WoS. There are more studies on green innovation published in non-indexed journals that are not accessible through the WoS database. Second, the citation index and the number of publications are frequently used to measure quality and quantity, respectively, despite the actual quality of the document. Podsakoff et al. (2008) argued that the number of articles was less significant than the number of citations, as the latter is considered a better approach to a researcher's impact and influence. Nonetheless, the mere fact that an author is considered important or relevant often persuades other authors to cite that particular author without reading his or her articles or developing a decisive or specific view of their content (Albort-Morant and Ribeiro-Soriano, 2015). Third, the problem of different authors with the same names, which is a general problem in the use of this method. Fourth, four different terms are used interchangeably in the literature to describe innovations that contribute or are intended to diminish the organisations' negative effect on the environment: "green", "environmental", "sustainable" and "eco". This is a serious problem as it results in overlapping definitions riddled with inconsistencies. Fifth, while the results contribute a picture of the current situation, this situation may change over time, especially for the publications from the past two years that still have to grow considerably in terms of the number of citations. Finally, it should be noted that this work is developed within a specific field: green innovation. Therefore, researchers should be cautious about generalising these conclusions.

For future research studies, scholars might reflect conducting a bibliometric analysis using other databases (e.g., Google Scholar or Scopus), which would contribute to gathering more information and reaching a better understanding of the topic. Future research could also use a structural indicator, which measures the relationships among publications, authors and areas of knowledge using sociograms.

Finally, further studies could narrow the focus of the bibliometric analysis by studying only GI articles published in English or by comparing the terms “eco”, “sustainable”, “environmental” and “green” innovations with each other. In addition, it could be interesting to perform an analysis that reflects the current topics in the field and their evolution over time.

6. References

Aguilera-Caracuel, J., & Ortiz-de-Mandojana, N. (2008). Green innovation and financial performance an institutional approach. *Organizational Environment, 26*(4), 365-385.

Albort-Morant, G., & Ribeiro-Soriano, D. (2015). A bibliometric analysis of international impact of business incubators. *Journal Business Research, 69*(5), 1775-1779.

Araoz, C. F. (It's Not the how Or the what But the who: Succeed by Surrounding Yourself with the Best. Harvard Business Press, 2014.

Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness. *Academic Management Journal, 43*(4), 717-736.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Batagelj, V., & Mrvar, A. (2003). Pajek: Analysis and visualization of large networks. In Junser, M., & Mutzel, P. (Eds.), Graph drawing software (pp. 77-144). New York: Springer.

Bjork, B., Offer, A., & Söderberg, G. (2014). Time series citation data: The Nobel Prize in economics. Scientometrics, 98(1), 185-196.

Bouyssou, D., & Marchant, T. (2011). Ranking scientists and departments in a consistent manner. Journal of the American Society for Information Science and Technology, 62(9), 1761 1769.

Cadavid-Higuita, L., Awad, G., Cardona, F., & Jaime, C. (2012). A bibliometric analysis of a modeled field for disseminating innovation. *Estudios Gerenciales, 28*, 213-236.

Chang, C.H. (2011). The influence of corporate environmental ethics on competitive advantage: the mediation role of green innovation. *Journal of Business Ethics, 104*(3), 361-370.

Chen, Y. S. (2008). The driver of green innovation and green image – green core competence. *Journal of Business Ethics*, *81*(3), 531-543.

Chen, Y. S., Chang, C. H., & Lin, Y. H. (2014). The determinants of green radical and incremental innovation performance: Green shared vision, green absorptive capacity, and green organizational ambidexterity, *Sustainability, 6*(11), 7787- 7806.

Chen, Y. S., Chang, C. H., & Wu F. S. (2012). Origins of green innovations: the differences between proactive and reactive green innovations. *Management Decision*, *50*(3) 368-398.

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics, 67*(4), 331-339.

Chiou, T. Y., Chan, H. K., Lettice, F., & Chung, S. H. (2011). The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transportation Research Part E: Logistics and Transportation Review, 47*(6), 822-836.

Daim, T. U., Rueda, G., Martin, H., & Gerdsri, P. (2006). Forecasting emerging technologies: Use of bibliometrics and patent analysis. *Technological Forecasting and Social Change*, *73*(8), 981-1012.

De Bakker, F. G., Groenewegen, P., & Den Hond, F. (2005). A bibliometric analysis of 30 years of research and theory on corporate social responsibility and corporate social performance. *Business & Society, 44*(3), 283-317.

Díaz-García, C., González-Moreno, A., & Sáez-Martínez, F. J. (2015). Eco-innovation: insights from a literature review. *Innovation, 17*(1), 6-23.

Dresner, S. (2006). Principles of Sustainability, Earthscan Publications Ltd., London.

Duque-Oliva, E. J., Cervera Taulet, A., & Rodríguez Romero, C. (2006). A bibliometric analysis of models measuring the concept of perceived quality in providing internet service. *Innovar, 16*(28), 223-243

Durieux, V., & Gevenois, P. A. (2010). Bibliometric Indicators: Quality Measurements of Scientific Publication 1. *Radiology, 255*(2), 342.

Egghe, L. (2006). Theory and practise of the g-index. *Scientometrics*, *69*(1), 131-152

Gao, C., Sun, M., Geng, Y., Wu, R., & Chen, W. (2006). A bibliometric analysis based review on wind power price. *Applied Energy, 182*, 602-612.

Garfield, E. (2006). Citation Indexes for Science. *Science, 122*(3159), 108-111.

Gluch, P., Gustafsson, M., & Thuvander, L. (2009). An absorptive capacity model for green innovation and performance in the construction industry. *Construction Management and Economics, 27*(5), 451-464.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academic Management Review, 20*(4), 986-1014.

Hashim, R., Bock, A. J., & Cooper, S. (2015). The Relationship between Absorptive Capacity and Green Innovation. World Academy of Science, Engineering and Technology, International *Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, *9*(4), 1040-1047.

Hayami, Y. (1971). Elements of induced innovation: A historical perspective for the green revolution. *Explorations in Economic History, 8*(4), 445.

Henriques, I., & Sadorsky, P. (1999). The relationship between environmental commitment and managerial perceptions of stakeholder importance. *Academic Management Journal*, *42*(1), 87-99.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. Proceedings of the National Academy of Sciences, USA, 102(46), 16569-16572

Kemp, R., & Pearson, P. (2007). Final report of the MEI project measuring eco innovation. UM Merit Maastricht. Retrieved from http://www.merit.unu.edu/MEI/deliverables/MEI%20D15%20Final%20report%20about%20measuring%20eco-innovation.pdf

Kemp, R., Arundel, A., & Smith, K. (2001). Survey indicators for environmental innovation (paper presented to conference “Towards Environmental Innovation Systems” in Garmisch-Partenkirchen.

Klassen, R. D., & Whybank, D. C. (1999). The impact of environmental technologies on manufacturing performance. *Academic Management Journal*, *42*(6), 599–615.

Lai, S. -B., Wen, C. T., & Chen, Y. S. (2003). The Exploration of the Relationship between the Environmental Pressure and the Corporate Competitive Advantage, CSMOT Academic Conference (National Chiao Tung University, Hsin-Chu).

Leal-Millán, A., Roldan, J. L., Leal-Rodríguez, A. L., & Ortega-Gutiérrez, J. (2016), IT and relationship learning in networks as drivers of green innovation and customer capital: Evidence from the automobile sector. *Journal of Knowledge Management, 20*(3), 444-464.

Leenders, M. A., & Chandra, Y. (2013). Antecedents and consequences of green innovation in the wine industry: the role of channel structure. *Technological Analysis Strategic, 25*(2), 203-218.

Merigó, J. M., Gil-Lafuente, A. M., & Yager, R. R. (2015). An overview of fuzzy research with bibliometric indicators. *Applied Soft Computing, 27*, 420-433.

O’Connor, G.C., Leifer, R., Paulson, A. S., & Peters, L. S. (1992). Grabbing Lighting: Building a Capability for Breakthrough Innovation, Jossey-Bass, San Francisco, CA., 2008

Persson, O., Danell, R., & Schneider, J. W. (2009). How to use Bibexcel for various types of bibliometric analysis. Celebrating scholarly communication studies: A Festschrift for Olle Persson at his 60th Birthda,, 9-24.

Podsakoff, P. M., MacKenzie, S. B., Podsakoff, N. P., & Bachrach, D. G., (2008). Scholarly influence in the field of management: A bibliometric analysis of the determinants of university and author impact in the management literature in the past quarter century. *Journal of Mangement, 34*(4), 641-720.

Porter, M. E., & Van der Linde, C. (1995). Green and competitive. *Harvard Business Research, 73*(5), 120-134.

Rueda, G., Gerdsri, P., & Kocaoglu, D. F. (2007). Bibliometrics and Social Network Analysis of the Nanotechnology Field. *Management of Engineering and Technology*, 2905-2911.

Russo, M. V., & Fouts, P. A. (1997). A resource-based perspective on corporate environmental performance and profitability. *Academy of management Journal, 40*(3), 534-559.

Saatçioğlu, Ö. Y., Çaylan, D. Ö., & Ozeren, E. (2016). Profiling innovation research in social sciences citation index (2009 to 2014).

Schiederig, T. Tietzer, F., & Herstatt, C. (2012). Green innovation in technology and innovation management– an exploratory literature review. *R&D Management, 42*, 180-192.

Subramaniam, M., & Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management journal*, *48*(3), 450-463.

Tseng, M. L., Huang, F. H., & Chiu, A. S. (2012). Performance drivers of green innovation under incomplete information. *Procedia-Social and Behavioral Sciences, 40*, 234-250.

Tseng, M. L., Wang, R., Chiu, A. S., Geng, Y., & Lin, Y. H. (2013). Improving performance of green innovation practices under uncertainty. *Journal of Cleaner Production, 40*, 71-82.

Van Raan, A. F. J. (2005). Fatal attraction: Conceptual and methodological problems in the ranking of universities by bibliometric methods. *Scientometrics, 62*(1), 133–143.

Van Raan, A. F. J. (2006). Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups. *Scientometrics, 67*(3), 491-502.

Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of operations management*, *22*(3), 265-289.

CHAPTER 4

The antecedents of green innovation performance: A model of learning and capabilities

CHAPTER 4: The antecedents of green innovation performance: A model of learning and capabilities

Abstract:

Environmental management and green practices have a narrow linkage with firm innovativeness. Companies that are pioneers in green innovation strategies might reach and sustain competitive advantages. Thus, successful green innovation performance (GIP) helps firms to achieve greater efficiency as well as to establish and strengthen their core competences. This study focuses on the dynamic capabilities (DC) and ordinary capabilities (OC) like antecedents of GIP, and the relationship between these constructs. Proposing a mediation model to analyze both direct and indirect relationship, this study applies variance-based structural equation modeling through a partial least squares to a sample of 112 firms from the Spanish automotive components' manufacturing sector. The results suggest that both the direct effect and indirect effect of capabilities (DC and OC) on GIP are positive and significant, and improve the prediction of firm's GIP. Furthermore, the structural model supports that DC influence GIP by reconfiguring relationship-learning capabilities (a type of OC).

Keywords: Dynamic capabilities; ordinary relationship learning capabilities; green innovation performance; Partial Least Square

1. Introduction

The ecofriendly impact of the human behavior is a constantly growing global concern for people, policy makers, countries, and organizations. Governments have applied corrective policies in the last years to diminish or palliate such environmental damage (Chen, 2008). Companies are not immune to this reality. On the contrary, as every multifaceted system in search for the equilibrium that will ensure long-term survival, companies should respond successfully to a dual adjustment dynamic. On the one hand, to reach a clear level of market efficiency, which involves enhancing the use of its resources and capabilities, which always have a limit—competitive adjustment. On the other hand, to overcome a certain degree of consistency with the society within which the organization operates—legitimacy adjustment.

In order to subsist inside the presently stormy and hypercompetitive scenarios, companies must foster innovativeness. To this end, companies must remain up to date of the manifold market changes, fluctuations, and tendencies that are persistently arising. This objective involves a customer orientation, and a green orientation strategy. In this line, the ultimate aim of developing a green product/service innovation strategy deals with enhancing the firm's survival and performance (Laforet, 2009).

The increasing societal demands compel companies to integrate sustainability topics into their regular activity so that companies can reach their social, environmental, and economic goals. Two major driving forces promote green management (Chen, 2008): (1) the international set of norms and regulations concerning environmental protection, and (2) the consumers' environmental consciousness (Chen et al., 2006). Whatever are the goals that lead companies to undertake environmental management—complying with environmental laws and regulations, becoming more competitive, gaining legitimacy, etc.—integrating environmental sustainability issues into business strategy and greening the innovation process are becoming a strategic opportunity for companies (Porter & Reinhardt, 2007). Hence, following several studies, environmental management and green practices present a narrow linkage to firm innovativeness (Aragón-Correa, 1998; Pérez-Valls et al., 2015).

In this sense, companies that are pioneers on green innovation strategies might be able to reach and sustain competitive advantages. Thus, successful green innovation performance (GIP) helps companies to achieve greater efficiency as well as to establish and strengthen their core competences and to enhance their green image. Consequently, all these actions may eventually enable companies to reach superior performance and higher profitability (Chen, 2008).

Literature on the capabilities-based view and the knowledge-creating view of the firm focuses on both ordinary capabilities (OC) and dynamic capabilities (DC) as the most valuable antecedents that provide sustainable competitive advantage, and on interaction as a key component for the access, attainment and development of new knowledge that is necessary to improve the results of innovation. Interaction may take place within a firm and between firms and other organizations. Firms use different networking mechanisms to access knowledge outside their frontiers. Extensive literature discusses various organizational features corresponding to different mechanisms that facilitate knowledge flows among different actors and enable relational learning activities.

This situation is even more critical in natural-resources intensive sectors, such as the automotive industry, which causes an important environmental impact. For this reason, firms must consider any measure aiming at improving those sectors' environmental efficiency and at enhancing the GIP. However, little empirical research addresses the question of how different capabilities, as antecedents, affect the improvement of GIP. This study focuses on the automotive sector.

This study examines the extent to which the existing internal capabilities of firms and their interaction with external sources of knowledge—enhancement relationship learning—affect their level of GIP. Section two reviews the theoretical framework that forms the basis of this empirical analysis. Section three presents an empirical analysis building on information about 112 firms from the Spanish automotive components' manufacturing sector. Finally, section four summarizes the results and discusses the main points arising from the analysis. The results confirm the positive role on GIP of both the direct effect and indirect effect of firm capabilities. Furthermore, the findings support that DC influence GIP by reconfiguring relationship-learning capabilities and accessing knowledge outside firms' boundaries.

2. Theoretical background

2.1.Green Innovation Performance (GIP)

In the environmental era, firms should integrate ideas to protect the environment. For this reason, green innovation is essential for firm’s business management. An efficient management can create value, leverage a competitive advantage, and increase the firm’s performance (Chen and Chang, 2013).

Innovation is an important way to mitigate or avoid environmental damage. Green technologies provide two main benefits for organizations: the commercial rewards from creating environmentally sustainable products, and the financial benefits that can increase competitiveness. Customers around the world want and expect to purchase ever more environmentally friendly products and services. Certainly, green innovation is a strategic need for firms which offers a great chance for meeting customers’ demands without harming the ecosystem.

Historically, firms have seen investing in eco-friendly behaviors as an excessive investment, but today’s strict ecological rules and the prevalence of environmentalism are changing competitive strategies, policies, and patterns for firms (Porter & Reinhardt, 2007). The ‘green’ label is an incentive for continuous innovation, creating new market opportunities for firms to satisfy new consumer demands and thus create value and improve performance.

Green innovation can consist of either green products or green processes. Green innovation comprises innovation in technologies for energy saving, pollution prevention, waste recycling, green product designing, and corporate environmental management (Chen et al., 2006).

2.2. The link between dynamic capabilities, relationship learning—as ordinary capabilities—and the firm’s GIP

In line with the resource-based view (RBV), the differences in performance between companies owe to their specific sets of resources and capabilities. Therefore, such resources and capabilities are the source of competitive advantage (Helfat & Peteraf, 2003). The RBV assumes the heterogeneous distribution of resources and capabilities among companies and its maintenance over time (Ambrosini & Bowman, 2009).

At the current period of widespread crisis, with a significant shortage of resources in all sectors, organizations need more than ever to be able to distribute their available resources among the alternatives, to try to adapt in the best way and as quickly as possible to the turbulence of the environment (Prahalad & Ramaswamy, 2004). Consequently, organizations must develop DC to evolve, advance, grow, adapt, and, ultimately, survive. Such DC development allows companies to sit some firm foundations that support their strategy. Nonetheless, although DC's outlook follows the RBV (Makadok, 2001), and RBV highlights resource combinations selection, DC emphasizes resource regeneration. This way, DC are the capacity of the firm to reconfigure resources into new combinations of ordinary—or operational—capabilities (OC).

The literature offers numerous definitions of DC. The concept of DC has undergone a terminological evolution thanks to the contributions and disagreements of different authors. Teece et al. (1997) first coin this concept and define DC as firms' ability to integrate, build, and reconfigure internal and external competencies to manage rapidly changing environments. Cepeda and Vera (2007) and Zahra et al. (2006) refer to DC as the processes to reconfigure a firm's resources and operational routines in the manner that its principal decision-makers envision and deem appropriate.

This article adopts Pavlou and El Sawy's (2011, p. 243) conceptualization. Extending earlier works by Teece (2007) (sensing the environment to seize opportunities and reconfigure assets), and Teece et al. (1997) (reconfiguring, learning, integrating, and coordinating), these authors propose a framework that contains four DC that function as tools that enable the reconfiguration of existing operational capabilities: (1) sensing, (2) learning, (3) integration, and (4) coordination capabilities.

Several authors propose the need to differentiate among types of processes and routines available in firms. Thus, Zollo and Winter (2002) and Winter (2003) distinguish between ordinary—operational—(zero-order) and dynamic (first-order) capabilities. Ordinary capabilities focus on the operational working of the firm, including both staff and line activities; these are "how we earn a living now" capabilities. Dynamic capabilities relate to the transformation of ordinary capabilities causing changes in the firm's products or production processes, or create new ordinary capabilities.

Karna et al. (2015) distinguish five categories of ordinary capabilities: (1) operations/processes, (2) product/service/quality, (3) resources/assets, (4) organization/structure, and (5) customer/supplier relationships. This study uses customer/supplier relationships because of the importance that the innovation literature grants to knowledge sharing and relational learning activities.

When firms share information and knowledge with customers and suppliers, they enhance their knowledge base, capabilities, and competitiveness through relationship-level learning. This framework broadly adopts the meaning from Cheung et al. (2011) and the original definition from Selnes and Sallis (2003, p. 86) of the relationship-learning activities:

[Relationship learning activities are] "an ongoing joint activity between the customer and the supplier organizations directed at sharing information, making sense of information, and integrating acquired information into a shared relationship-domain–specific memory to improve the range or likelihood of potential relationship-domain–specific behavior".

Relationship learning is thus a process to increase future behavior in a relationship. This study proposes that relationships vary in terms of their relationship learning capabilities (RLC), and thus some relationships perform better because they have developed appropriate learning mechanisms. Following Selnes and Sallis (2003), this study's research model presents RLC as a construct comprising three ordinary capabilities: (1) information sharing capability (ISC), (2) joint sense-making capability (JSC), and (3) knowledge integration capability (KIC).

The foundation of cooperative nets between companies and stakeholders is critical in innovation progress (Bossink, 2002). Through alliances and relationships, organizations can effectively innovate by sharing complementary assets and skills (Powell, 1998). Organizations can consequently create partnerships, joint ventures, inter-firm nets, and R&D conglomerates (Doz et al., 2000). This idea is the basis of Chesbrough's (2003) open innovation theory, which argues that companies can combine external and internal ideas and market pathways to take advantage of their technologies. A fruitful green innovation process requires collaboration and knowledge exchange with external stakeholders. Furthermore, many organizations lack knowledge and capabilities to foster green innovations. For example, in the automotive components' manufacturing sector, if a company needs to reduce its products' environmental impact—supposing that the company does so at many points in the supply chain and that the firm itself does not participate in all product manufacturing stages—collaboration with other companies in the product's value chain is necessary (Petruzzelli et al., 2011). Additionally, the sophistication of ecological problems forces firms aiming to perform green innovations to build a solid, broad net of links with their customers and suppliers (Ngai et al., 2008). These stakeholders are a source of eco-friendly knowledge and capabilities outside the firm's core domain. The relevance of RLC in developing green innovations is so essential.

The capabilities-based view of the firm proposes that, to gain competitive advantage, firms need OC, which let them operate their selected outlines of business efficiently, and DC, which assist them to promote existing OC or to create new ones (Karna et al., 2015). However, a strong debate exists over this field, "riddled with inconsistencies, overlapping definitions, and outright contradictions" (Zahra et al., 2006, p. 917). Even today, the relationship between DC, OC, and competitive advantage and performance remains controversial.

The literature provides extensive, although not general, evidence of the enhancing effect of DC and OC on innovation and performance (Karna et al., 2015). On the one hand, some authors and several empirical studies suggest a direct effect of DC on performance and competitive advantage (Karna et al., 2015; Teece, 2007; Teece et al., 1997). On the other hand, some authors disagree with this direct relationship between DC and performance. For instance, Helfat et al. (2007) decouple the notion of DC and performance and contend that DC do not unavoidably lead to competitive advantage, because although DC may change the resource base, DC may not create any valuable, rare, inimitable, and none-substitutable (VRIN) resources (Zahra et al., 2006; Eisenhardt & Martin, 2010). This view questions the direct relationship between DC and performance. Instead, Pavlou and El Sawy (2011) propose an indirect relationship. These authors offer empirical evidence that DC indirectly influence performance by reconfiguring existing operational (ordinary) capabilities into superior ones that better match the changing environment. Therefore, Pavlou and el Sawy (2011) also differentiate between OC and DC, and argue that competitive advantage and performance come from new configurations of resources and OC, and not from DC per se, introducing the mediating role of OC in the relationship between DC and performance in new product development.

Recently, Karna et al. (2015) investigate the role of OC and DC as drivers of the financial performance of firms under different environmental conditions by meta-analyzing 115 empirical studies comprising 121 samples. Their results suggest that the performance effects of both types of capabilities are positive and similar in magnitude. Environmental dynamism reinforces the effects of both ordinary and dynamic capabilities. Furthermore, the two types of capabilities present a close association. These findings provide support for a moderate capabilities-based view of the firm, rather than one that considers dynamic capabilities as superior to ordinary ones. Therefore, Karna's study reaffirms the idea that variations in capabilities across firms are central to explaining variations in competitive advantages and performance.

H1: Dynamic capabilities relate positively to firm's GIP.

H2: RLC (like OC) relate positively to firm's GIP.

H3: DC relate positively to RLC (like OC).

H4: RLC (like OC) positively mediate the relationship between DC and GIP.

This study presents a research model with the relationships between DC, GIP, and RLC are related (Figure 1).

3. Method

3.1. Data collection and sample

This research focuses on the automotive components' manufacturing sector in Spain—one of the fastest growing sectors in the country. Such industry presents a high knowledge intensity, innovativeness, and product-oriented products—mainly major automobile manufacturers (e.g., Ford, Citroen, Renault, Peugeot.). These companies provide components and highly customized products and services to large automakers.

On the one hand, these firms act as external knowledge sources for their client firms. On the other hand, they are increasingly becoming independent innovation creators. Most firms in the automotive components manufacturing sector are SMEs. Firms that incorporate the specialist knowledge and capabilities to develop effective green innovations create customer value and have an advantage regarding differentiating their products from their competitors.

The sample comes from a list of Sernauto, the Spanish association of automotive equipment and components manufacturers. From the 960 companies in the sector, 387 firms that carry out green innovation received the questionnaire. After two remainders, the study obtains 112 usable surveys, representing a response rate of 28.94 %. The low response rate for this sample owes to the fact that only top executives can answer the questionnaire.

3.2. Measures

This study uses a seven-point Likert scale from high disagreement to high agreement to measure the questionnaire items. The study uses 19 items from Pavlou and El Sawy (2011) to measure DC. Three dimensions define RLC: information sharing, joint sense-making, and knowledge integration (Selnes & Sallis, 2003). In the final scale, 17 items measure these three components. Finally, the study follows Chen et al. (2006) to measure GIP and its measurement includes eight items. The design of the measurement model presents reflective first-order dimensions (i.e., sensing capability, learning capability, integrating capability, and coordinating capability) and a reflective second-order construct (i.e., DC). In this case, the study focuses on the common variance, that is, the variance common to the four dimensions. Because of space restrictions, readers may request a copy of the questionnaire to the corresponding author.

3.3. Data analysis

The study uses Partial Least Squares (PLS) path-modeling, a variance-based structural equation modeling (SEM) technique to test the model (Roldán & Sánchez-Franco, 2012). PLS simultaneously enables the assessment of the reliability and validity of the measures of theoretical constructs (outer model) and the estimation of the relationships among these constructs (inner model) (Barroso et al., 2010). The following reasons justify the use of PLS: (1) this study aims at predicting dependent variables (Chin, 2010); (2) the sample (n = 112) is small and, according to Reinartz et al. (2009), studies should apply PLS when the number of observations is lower than 250; (3) the research model is complex, both in the type of variables (first- and high-order constructs) and in the hypothesized relationships (direct and indirect or mediated effects); and (4) this study uses latent variables scores in the subsequent analysis for a predictive relevance (Hair et al., 2011). The study employs the SmartPLS 2.0 software (Ringle et al., 2005).

The operationalization of the multidimensional superordinate constructs follows a two-step approach (Chin, 2010). Accordingly, the study optimally weights and combines the items for each dimension using the PLS algorithm to create a latent variable score. As a result, the dimensions or first-order factors became the observed indicators of the second-order construct, that is, the DC and RLC variables (Chin & Gopal, 1995).

4. Results

The interpretation of the PLS model comprises two phases: measurement model (outer model), and structural model (inner model). This sequence ensures that the measures of constructs are reliable and valid before attempting to draw conclusions with respect to the relationships between constructs (Roldán & Sanchez-Franco, 2012).

4.1. Measurement model results

The measurement model involves assessing reliability and validity. The model of measure is completely satisfactory (Tables 1 and 2). First, the individual reliability of items is suitable. Accordingly to Hair et al. (2014), the indicator's outer loadings should be higher than 0.707. Hence, the individual item reliability is adequate (Carmines & Zeller, 1979). Second, the construct reliability requirement is also adequate because all reflective constructs present composite reliabilities (ρc) greater than 0.7 (Nunnally & Bernstein, 1994). These latent variables reach convergent validity because their average variance extracted (AVE) measures are over 0.5 (Fornell & Larcker, 1981).

Finally, all variables present discriminant validity according to the Fornell-Larcker and the Heterotrait-monotrait (HTMT) criteria (Table 2). On the one hand, Fornell-Larcker involves comparing the square root of AVE with the correlations. For satisfactory discriminant validity, the diagonal elements (in bold) should be significantly higher than the off-diagonal elements in the corresponding rows and columns (Fornell-Larcker, 1981). On the other hand, the Heterotrait-monotrait (HTMT) ratio of correlations evaluates the average of the Heterotrait-Heteromethod correlations (Henseler et al., 2014).

Table 1. Measurement model: loadings, construct reliability and convergent validity

Construct/dimension/indicator	Loading	Composite	Cronbachs	Average variance
		Reliability (CR)	Alpha	Extracted (AVE)
Dynamic Capabilities (DC)		0.97	0.96	0.90

Sensing Capability (SC)	0.92	0.89	0.84	0.68
DC_SC1	0.80			
DC_SC2	0.83			
DC_SC3	0.80			
DC_SC4	0.86			
Learning Capability (LC)	0.96	0.90	0.87	0.66
DC_LC1	0.83			
DC_LC2	0.75			
DC_LC3	0.74			
DC_LC4	0.84			
DC_LC5	0.87			
Integrating Capability (IC)	0.94	0.94	0,93	0.78
DC_IC1	0.90			
DC_IC2	0.85			
DC_IC3	0.88			
DC_IC4	0.90			
DC_IC5	0.88			
Cordinating Capability (CC)	0.96	0.92	0.90	0.72
DC_CC1	0.95			
DC_CC2	0.86			
DC_CC3	0.87			
DC_CC4	0.68			
DC_CC5	0.89			
Green Innovation Performance (GIP)		0.91	0.91	0.93
GIP1	0.85			
GIP2	0.82			
GIP3	0.82			
GIP4	0.85			
GIP5	0.73			
GIP6	0.88			
GIP7	0.70			
GIP8	0.75			
Relationaship Learning Capabilities (RLC)		0.97	0.95	0.91
Information Sharing Capability (ISC)	0.97	0.90	0.88	0.59
RL_ISC1	0.78			
RL_ISC2	0.85			
RL_ISC3	0.77			
RL_ISC4	0.73			
RL_ISC5	0.80			
RL_ISC6	0.73			

RL_ISC7	0.67			
Joint Sensemaking Capability (JSC)	0.94	0.85	0.77	0.60
RL_JSC8	0.77			
RL_JSC9	0.86			
RL_JSC10	0.58			
RL_JSC11	0.85			
Knowledge Integration Capability (KIC)	0.95	0.88	0.84	0.57
RL_KIC12	0.66			
RL_KIC13	0.79			
RL_KIC14	0.77			
RL_KIC15	0.62			
RL_KIC16	0.81			
RL_KIC17	0.83			

Table 2. Measurement model: discriminant validity

	Fornell-Larcker Criterion				Heterotrait-Monotrait Ratio (HTMT)		
	DC	GIP	RLC		DC	GIP	RLC
DC	**0.95**			DC			
GIP	0.92	**0.96**		GIP	0.83		
RLC	0.92	0.94	**0.95**	RLC	0.84	0.87	

Notes: DC: dynamic capabilities; GIP: green innovation performance; RLC: relational learning capabilities. Fornell-Larcker Criterion: Diagonal elements (Bold) are the square root of the variance shared between the constructs and their measures (AVE). Off-diagonal elements are the correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements.

4.2. Structural model results

The study assesses the structural model on the basis of the algebraic sign, magnitude, and significance of the structural path coefficients. The R^2 values assess predictive significance. Table 3 shows the explained variance (R^2) in the endogenous variables and the path coefficients for the two models under study (model 1 with direct relationship and model 2 with indirect or mediating effect). Following Hair et al.'s (2011) operation, this study uses a resampling bootstrapping (5000 resamples) to generate the standard errors and t-values (t-statistics). These results allow to check the significance statistics of the hypothetical relationships.

The three direct effects in Figure 1b (model 2) are significant. Model 1 (Figure 1a) describes a positive direct effect of DC on GIP (c = 0.93; t-value= 75.06). However, in the presence of RLC as a mediator variable (H4), the direct DC-GIP relationship diminishes. Thus, model 2 (Figure 1b) shows how the direct relationship between DC and GIP, although significant, is lower than the relationship in model 1 (c = 0.397; t-value = 4.428). These results support the mediation hypothesis.

Figure 1. Structural model

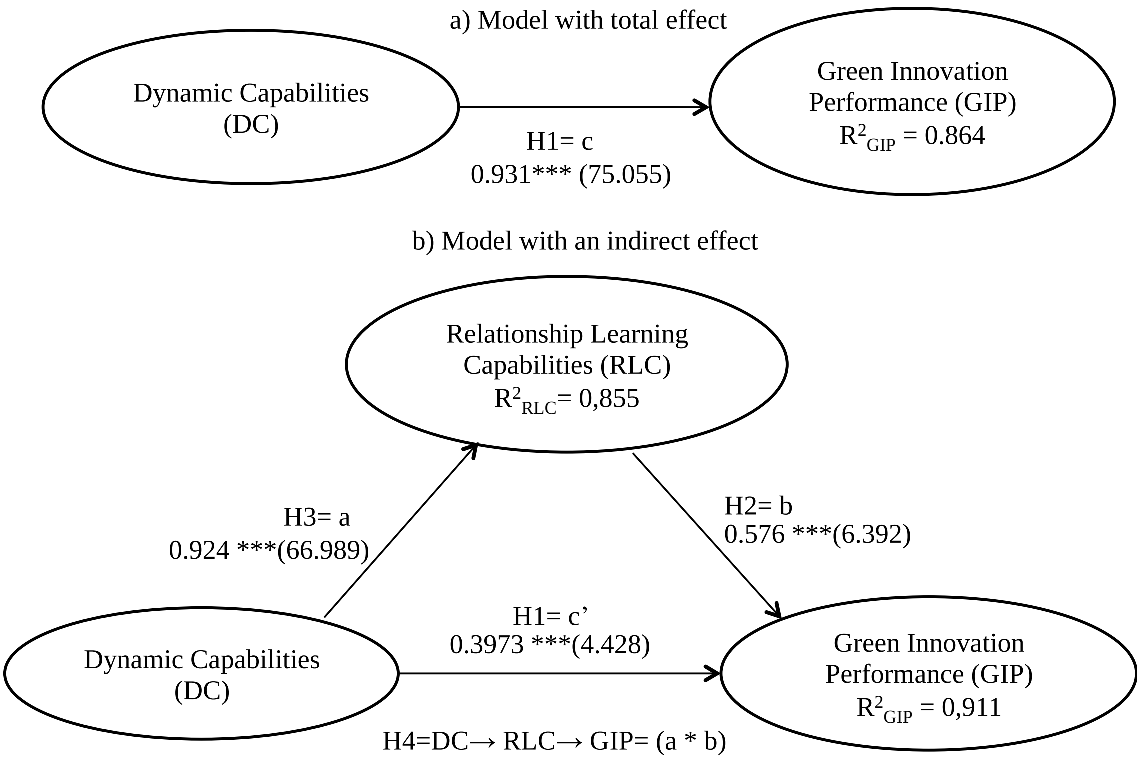


Table 3 shows that the indirect effect of DC on GIP via RLC is consistently positive and increases with increasing levels of RLC. Bootstrap confidence interval to the 95% for the indirect effect is always greater than zero (Baron & Kenny, 1986). Therefore, RLC mediates the relationship between DC and GIP. Following Williams and MacKinnon's (2008) proposals, the study uses the bootstrapping technique to test the mediation effect. Chin (2010) suggests using the specific model in question including both direct and indirect paths, performing N-bootstrap resampling, and finally multiplying the direct paths that make up the indirect path under evaluation. This study's 5000 resamples also generate 95% confidence intervals (percentile) for the mediators (Table 3) (Picón et al., 2014).

Table 3. Structural model results

	Model 1		**Model 2**			
	R^2_{GIP} = 0.864		R^2_{GIP} = 0.91 R^2_{RLC} = 0.85			
Relationships	Path coefficient	Support	Path coefficient	Percentile Bootstrap 95% CI Lower	Upper	Support
H1: DC→GIP	0.93*** (75.05)	Yes	0.39*** (4.42)	0.20	0.57	Yes
H2: RLC→GIP			0.92*** (66.98)	0.89	0.94	Yes
H3: DC→RLC			0.57*** (6.39)	0.40	0.76	Yes

Notes: DC: Dynamic capabilities; GIP: Green innovation performance; RLC: Relationship learning capabilities.

t values in parentheses: t(0.05, 4999) = 1.645; t(0.01, 4999) = 2.327; t(0.001, 4999) = 3.092.

* p < 0.05. ** p< 0.01. *** p< 0.001.

5. Conclusions

Several studies argue the existence of a direct link between firms' capabilities and financial performance (Karna et al., 2015; Teece, 2007; Zahra et al., 2006). However, no studies focus on the influence of the internal capabilities on other outcome' measures such as GIP. In comparison to conventional innovation and new product development, the study of green innovation is relatively new in the academe field even though scholars' interest on green innovation has grown in recent years (e.g., Chung & Tsai, 2007; Pujari et al., 2003; Rehfeld et al., 2007). Building on previous literature, this study develops a research model that links DC, RLC, and GIP with the purpose of clarifying the existing relationships between DC and GIP and assessing whether new ordinary capabilities (RLC) mediate this link. This study is in line with other works that focus on the outcomes of firm' capabilities, contributing to the debate of fostering green and competitive firms (e.g., Chen & Chang, 2013; Chen et al. 2006; Lefebvre et al. 2003).

The results suggest that both the direct effect and indirect effect of DC and RLC on GIP are positive and significant. Furthermore, the structural model supports that DC influence GIP by reconfiguring RLC, thus supporting the indirect effect of DC-GIP and the important mediator role of RLC.

This article makes three contributions to the literature. First, by making an explicit distinction between DC and a new OC (RLC), the study clarifies the nature of green innovation. Second, the study tests the effect of DC and RLC through a survey research with a sample of 112 firms on the GIP; a new measure of performance in the literature on this topic. Third, the mediation model provides practical steps for managers with an interest in dynamic and relationship learning capabilities supporting green innovation.

The study has some limitations. First, this study provides only a photo of continuing processes. Consequently, this study does not investigate the intricacies of the processes and capabilities over time. Future research should incorporate a longitudinal study that takes measures at different points in time and proves the relations established in the theoretical model. Second, although the study defines the constructs as rigorously as possible, these definitions come from appropriate literature in which specialists validate them, and thus are only proxies for underlying immeasurable latent phenomena.

For successive research, the use of supplementary items may aid to apprehend the fruitfulness of the constructs addressed in this investigation. Third, the model in this study does not capture possible moderating effects of environmental turbulence. Companies competing in the same industry face similar input and output market as well as technological conditions, thus defining the task environment in which firms operate.

Previous research shows that the influence of cognitive issues on individual, group, and organizational performance can change considerably depending on environmental conditions. Additionally, other factors or variables absent in this study may affect the constructs discussed herein.

6. References

Ambrosini, V., & Bowman, C. (2009). What are dynamic capabilities and are they a useful construct in strategic management?. *International Journal of Management Reviews, 11*(1), 29–49.

Aragón-Correa, J. A. (1998). Strategic proactivity and firm approach to the natural environment. *Academy of Management Journal, 41*, 556–567.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 11–73.

Barroso, C., Cepeda, G., & Roldán, J. L., (2010). Applying maximum likelihood and PLS on different sample sizes: studies on SERVQUAL model and employee behaviour model. In Esposito Vinzi, V., Chin, W.W., Henseler, J., et al. (Eds.), Handbook of Partial Least Squares: Concepts, Methods and Applications. Springer-Verlag, Berlin, 427–447.

Bossink, B. A. G. (2002). The development of co-innovation strategies: Stages and interaction patterns in interfirm innovation. *R&D Management, 32*(4), 311–320.

Carmines, E. G., & Zeller, R. A. (1979). Reliability and validity assessment (Vol. 17). Sage Publications.

Cepeda, G., Vera, D. (2007). Dynamic capabilities and operational capabilities: A knowledge management perspective. *Journal of Business Research, 60*(5), 426–437.

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics, 67*(4), 331–339.

Chen, Y. S. (2008). The driver of green innovation and green image – green core competence. *Journal of Business Ethics, 8*(3), 531–543.

Chen, Y. S., & Chang, C. H. (2013). The determinants of green product development performance: Green dynamic capabilities, green transformational leadership, and green creativity. *Journal of Business Ethics, 116*(1), 107–119.

Chesbrough, H. (2003). Open innovation: The new imperative for creating and profiting from technology. Cambridge, MA: Harvard Business School Publishing.

Cheung, M.-S., Myers, M. B., & Mentzer, J. T. (2011). The value of relational learning in global buyer-supplier exchanges: A dyadic perspective and test of the pie-sharing premise. *Strategic Management Journal, 32*, 1061–1082.

Chin, W. W. (2010). How to write up and report PLS analyses. In V. Esposito Vinzi, W.W. Chin, J. Henseler, & H. Wang (Eds.) Handbook of Partial Least Squares Concepts, Methods and Applications, Springer, Dordrecht, 645–689.

Chin, W. W., & Gopal, A. (1995). Adoption intention in GSS: Relative importance of beliefs. *ACM SigMIS Database, 26*(2–3), 42–64.

Chung, Y., & Tsai, C. (2007). The effect of green design activities on new product strategies and performance: An empirical study among high-tech companies. *International Journal of Management, 24*(2), 276–288.

Doz, Y. L., Olk, P. M., & Smith Ring, P. (2000). Formation processes of R&D consortia; which path to take: Where does it lead?. *Strategic Management Journal, 21*(3), 239–266.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50.

Garfield, E. (1955). Citation indexes for science: a new dimension in documentation through association of ideas. *Science, 122*, 108–111.

Hair, J. F., Hultt, G. T. M., Ringle, C., & Sarstedt, M. (2014). A primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Los Angeles: SAGE Publications, Inc.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing theory and Practice, 19*(2), 139–152.

Helfat, C., & Peteraf, M. (2003). The dynamic resource-based view: Capability lifecycles. *Strategic Management Journal*, *24*(10), 997–1010.

Helfat, C., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. G. (2007). Dynamic Capabilities: Understanding Strategic Change in Organizations. Malden, MA: Wiley-Blackwell.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115–135.

Karna, A., Richter, A., & Riesenkampff, E. (2015). Revisiting the role of the environment in the capabilities–financial performance relationship: A meta-analysis. Strategic Management Journal, Published online EarlyView in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/smj.2379

Laforet, S. (2009). Effects of size, market and strategic orientation on innovation in non-high-tech manufacturing SMEs. *European Journal of Marketing, 43*(1–2), 188–212.

Lefebvre, É., Lefebvre, L. A., & Talbot, S. (2003). Determinants and impacts of environmental performance in SMEs. *R&D Management, 33*(3), 263–283.

Makadok, R. (2001). Toward a synthesis of the resource-based and dynamic capability views of rent creation. *Strategic Management Journal*, *22*(5), 487–505.

Ngai, E. W. T., Jin, C., & Liang, T. (2008). A qualitative study of inter-organizational Knowledge management in complex products and Systems development. *R&D Management*, *38*(4), 421–440.

Nunnally, J. C., & Bernstein, I. H. (1994). The assessment of reliability. *Psychometric Theory, 3,* 248–292.

Pavlou, P. A., & El Sawy, O. A. (2011). Understanding the elusive black box of dynamic capabilities. *Decision Sciences*, *42*(1), 239–273.

Pérez-Valls, M., Céspedes-Lorente, J., & Moreno-García, J. (2015). Green Practices and Organizational Design as Sources of Strategic Flexibility and Performance. Business Strategy and the Environment. Published online EarlyView in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/bse.1881.

Petruzzelli, A. M., Dangelico, R. M., Rotolo, D., & Albino, V. (2011). Organizational factors and technological features in the development of green innovations: Evidence from patent analysis, Innovation: Management. *Policy & Practice, 13*(3), 291–310.

Picón, A., Castro, I., & Roldán, J. L. (2014). The relationship between satisfaction and loyalty: A mediator analysis. *Journal of Business Research, 67*(5), 746–751.

Porter, M., & Reinhardt, F. L. (2007). A strategic approach to climate. *Harvard Business Review, 85*(10), 22–26.

Powell, W. (1998). Learning from Collaboration: Knowledge and Networks in the Biotechnology and Pharmaceutical Industries. California Management Review, 40, 228–240.

Prahalad, C. K., & Ramaswamy, V. (2004). The future of competition. Cambridge, MA: Harvard Business School Press.

Pujari, D., Wright, G., & Peattie, K. (2003). Green and competitive - Influences on environmental wew product development performance. *Journal of Business Research, 56*(8), 657–671.

Rehfeld, K-M., Rennings, K., & Ziegler, A. (2007). Integrated product policy and environmental product innovations: An empirical analysis. *Ecological Economics, 61*(1), 91–100.

Reinartz, W., Haenlein, M., & Henseler, J. (2009). An empirical comparison of the efficacy of covariance-based and variance-based SEM. *International Journal of Research in Marketing, 26*(4), 332–344.

Ringle, C. M., Wende, S., & Will, A. (2005). SmartPLS 2.0 (M3) beta. Retrieved from: http:// www.smartpls.de (at Hamburg).

Roldán, J. L., & Sánchez-Franco, M. J. (2012). Variance-based structural equation modeling: Guidelines for using partial least squares in information systems research. In Mora, M. (Ed.) Research methodologies, innovations and philosophies in software systems engineering and information systems (pp. 193–221). Hershey, PA: IGI Global.

Selnes, F., & Sallis, J. (2003). Promoting relationship learning. *Journal of Marketing, 67*(1), 80–95.

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(8), 1319–1350.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533.

Williams, J., & MacKinnon, D. P. (2008). Resampling and distribution of the product methods for testing indirect effects in complex models. *Structural Equation Modeling*, *15*(1), 23–51.

Winter, S. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, *24*(10), 991–995.

Zahra, S. A., Sapienza, H. J., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: A review, model and research agenda. *Journal of Management Studies*, *43*(4), 917–955.

Zollo, M., & Winter, S. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organizational Science*, *13*(2), 339–351.

CHAPTER 5

Creating green innovations performance by fostering organizational knowledge and relations: Evidence from a coopetitive business network

CHAPTER 5: Creating green innovations performance by fostering organizational knowledge and relations: Evidence from a coopetitive business network

Abstract:

The main purpose of this study deals with exploring the ties existing among firms' knowledge bases (KB), relationship learning (RL) and green innovation performance (GIP) under a coopetitive framework. Hence, in this work we posit the hypothesis that green innovation is to a great extent directly influenced by an integrated broad and deep knowledge base. Besides, we hypothesize that the KB-GIP link is mediated by the relationship learning mechanisms (indirect effect). The research model and hypotheses proposed are empirically tested though the application of Partial Least Squares (PLS) path-modeling to a sample of 112 firms belonging to the Spanish automotive components manufacturing sector (ACMS). The results indicate that the mediated effect of RL on KB-GIP link is positive and significant. Therefore, managers should build strong relations with their stakeholders to assimilate, transfer and adapt a new knowledge base that can strengthen and stimulate the firm's green innovation performance.

Keywords: knowledge base, relationship learning, green innovation performance, coopetition, partial least squares

1. Introduction

In the last decades, with the growing concern for environmental issues, strict regulations and international conventions for the protection of the environment and the increase of environmentalism among consumers, companies have had to develop a series of strategies and policies linked to the environment. In such a context, green innovation performance (GIP) is used to enhance environmental management performance, in order to comply with the distinct requirements for the protection of the environment (Chen, Lai and Wen, 2006). Green innovation performance has been also defined as a firm's strategy that offers a great chance for meeting stakeholders' demands, linked with maximizing production without harming the ecosystem (Albort-Morant et al., 2016). Thus, environmental issues become a vital portion of organizations' corporate strategy because of the advent of severer environmental norms and protocols and increasing stakeholders' demands.

Hence, this type of innovation arises as a corporate reaction to internal –i.e., cultural shifts, managerial approach, etc.– or external changes –i.e., market trends, stakeholders' preferences, normative frameworks or societal demands. In others terms, organizations must continuously improve their products and processes, being able to develop them in an agile and quick way, with the final aim of attaining sustainable competitive advantages.

The framework of the knowledge-based view considers that knowledge is an essential strategic resource to generate new value creation and competitive advantage (Grant, 1996). Their knowledge base gives companies the possibility and ability to understand and make use of new knowledge to resolve problems, decision making or innovations (Ahuja and Katila, 2001). Hence, it is essential that companies develop the competence to build a deep and broad knowledge base that nurtures itself from both internal and external knowledge sources, and which might lead to the reinforcement and support of the innovative process, the launching of green innovative products and services.

This sort of innovation may involve a shift in the attitudes of the companies that seek to develop narrow relations with their stakeholders and partners (Lettice, Wyatt and Evans, 2010) and to have access to knowledge residing outside their frontiers. For this reason, companies must work closely with their stakeholders to share their knowledge and skills, also sharing their mutual aim to become 'greener' (Chiou, Chang and Lettice, 2011). This is particularly relevant for SMEs, where knowledge about suppliers, customers, partners or competitors will be generated with the personal contact between organizational members and stakeholders.

An example of this is in companies which operate through supply chains or by projects, where developing strong client–supplier relationships is essential for effective and efficient management. In order to attain and sustain green relationship learning it is essential to assure the cooperation of the parts involved. Therefore, strengthening relationship learning is vital for the firm's knowledge base to effectively attain green innovations.

In the decade of the 90s, the term "coopetition" appears as an attempt to give an explanation to certain ways of strategic alliances between companies. Coopetition is a buzzword invented to describe cooperative competition. The essential beliefs of coopetitive organizations have been explained in the game theory, a scientific arena that emerges with the book written by John von Neumann and Oskar Morgenstern "Theory of Games and Economic Behavior" in 1944, and subsequently developed by John Forbes Nash in non-cooperative games. Coopetition might happen in the interorganizational or intraorganizational spheres.

Intra-firm level coopetition occurs between individuals or operative divisions or units inside the same company. Grounded on game-theory and social interdependence theories, several research works explore the occurrence of simultaneous cooperation and competition between departments or operational units -the antecedents of coopetition- and its influence on knowledge sharing behaviors (Loebecke et al., 1999). In this way, the concept of "coopetitive knowledge sharing" is developed to explicate mechanisms through which coopetition influences effective knowledge sharing practices in cross-functional teams (Ghobadi and D'Ambra, 2012). The core argument is that while organizational teams need to cooperate, they are likely to experience strain caused by diverse professional values and opposing objectives from different cross-functional departments.

At the inter-firm level, coopetition happens when companies network with a limited correspondence of interests. They collaborate with each other to gain a higher value creation, if compared to the value created without collaboration, and fight to attain competitive advantage. Frequently coopetition occurs when firms in the same market work jointly in the exploration of knowledge and new products, whereas they contend for the market-share of their products and in the exploitation of the knowledge created at different levels in the value chain (Fernandes and Ferreira, 2017). One of these cases of coopetition is the one carried out by the PSA group (Peugeot-Citroën) and the Japanese company Toyota to share components for a small car, which is marketed by each company as the "Peugeot 107", the "Toyota Aygo", and the "Citroën C1". Numerous benefits can be achieved, such as cost cuttings, resources complementarity and knowledge or high-tech transfer.

There are also often coopetition situations concerning different companies working in supply chains, as is the case of the automotive components sector. Although there are also difficulties and risks, such as lack of confidence, etc., one of the great advantages that these companies obtain is the knowledge developed from relationship learning.

Numerous studies have pointed out the necessity to reinforce networks and cooperative ties as fundamental drivers of organizational success and green innovation performance (Lin and Chang, 2009; De Marchi, 2012; Cainelli et al., 2015). For instance, Lin and Chang (2009) explain the positive impact of green RL on GIP within a sample shaped by Taiwanese manufacturing firms. According to the empirical study developed by De Marchi (2012) within a sample of Spanish manufacturing firms, formal cooperation with external partners is more important for green innovation than other types of innovation. Moreover, Leal-Millán et al. (2016) reveal the positive effects of developing information technology capability and fostering relationship learning (RL) in green innovation performance and customer capital.

Similarly, Albort-Morant et al. (2016) describe the ties between dynamic capabilities and green innovation performance, introducing relationship learning as a mediating variable. Following this last study, we want to prove how the variable relationship learning acts as a mediator in the relationship between the knowledge base and green innovation performance. This is because we believe that the companies which have a strong knowledge base need to relate and learn from their stakeholders to have an updated knowledge base about environmental issues that enables them to create green innovation performance. Therefore, when companies share knowledge with suppliers and customers through supply chain management activities, they improve their knowledge base and capabilities through relationship-level learning.

Recently, the literature about cooperation has augmented in importance and size of publications to the extent that it favors the progress of core competencies and capabilities in the firms (Leal-Millán et al., 2017). In SMEs the collaboration with competitors, suppliers and customers is vital to create effective green innovation since organizations should expand the knowledge creation process beyond the company.

Nevertheless, the mediation of relationship learning in the link between the knowledge base and green innovation performance has not been sufficiently explored until now. Or at least, to the best of the authors' knowledge, no empirical research has been developed on this topic. Therefore, this paper aims to respond to these concerns and targets the above-identified gaps of the KB, GIP and RL literature.

Consequently, bearing in mind that KB and GIP are positively related and that there is a necessity to know more about which other coopetitive organizational mechanisms/capabilities managers need to activate to make green innovations more successful, the central research question addressed by this research work is “How does the presence of relationship learning (as an ordinary capability) actually affect the link between KB and GIP?” This paper theorizes and examines this central question. It involves the examination of whether relationship learning exerts a mediating role in the KB-GIP link. Thus, this work analyzes a model that links the above-stated constructs – knowledge base, relationship learning, and green innovation performance. In particular, we aim to shed light on if and how the deployment of an extensive relationship learning capability (in coopetitive conditions with a wide set of stakeholders and competitors) accentuates the effect that a broad and deep knowledge base exerts on the results of green innovation in industrial firms.

The study is organized as follows. Section 2 presents the main theoretical foundations along with the proposed research model and the hypothesis. Section 3 describes the empirical analysis based on a specific dataset containing information about 112 companies that compose the automotive components manufacturing sector (ACMS) in Spain. Section 4 offers the results of the data analysis carried out by means of applying partial least squares (PLS) path-modeling, a variance-based structural equation modeling technique. Finally, Section 5 brings together the discussion of results, the implications for research and practice and the future lines of research.

2. Theoretical Background

2.1. Knowledge Base

The Knowledge-based view (KBV) of the firm suggests that knowledge is a key strategic resource for companies aiming to generate and maintain sustainable competitive advantages (Grant, 1996). Whilst knowledge is produced and spread across the company, it has the potential to enhance organizational value by boosting its proficiency while reacting to new, unexpected or rare situations. The increasing relevance of knowledge as a fundamental organizational resource has driven managers to pay more attention to the development of knowledge management strategies. Thus, the KBV recommends that firms ought to develop, absorb and apply managerial knowledge to attain superior organizational performance (Nonaka, 1994), since knowledge is amongst a firm's most fundamental resources, if not the most critical one (Spender, 1996).

An organization's current knowledge base sets up its prospect and capability to recognize the value of new knowledge and apply it to decision-making processes, problems solving, or innovation generation (Ahuja and Katila, 2001). In this vein, Zhou and Wu (2010) affirm that a firm's present knowledge base (i.e., its knowledge breadth and depth), represents its main source of organizational innovativeness. Knowledge breadth and depth are the two components shaping an organization's knowledge base, and they disclose both the firm's main knowledge structures and contents. On the one hand, knowledge depth comprises the degree of intricacy and sophistication inherent to a firm's knowledge base (Bierly and Chakrabarti, 1996). This trait corresponds to the vertical dimension of knowledge, it being exclusive, complex, and highly specific. On the other hand, knowledge breadth seizes the horizontal dimension of knowledge, in other words, the wide heterogeneity of the firm's knowledge base (Zhou and Li, 2012).

Furthermore, knowledge can also be classified in several ways. The main taxonomies are: the systemic dimension (data, information and knowledge), the ontological dimension (individual–social), and the epistemological dimension (explicit–tacit). A firm's knowledge base nurtures itself from a wide variety of knowledge sources –internal and external to the company. Some knowledge will be more difficult to manage or articulate and, moreover, being able to retain some knowledge within the company's bonds constitutes a hard task. Hence, effectively managing the firm's knowledge base stands as a fairly worthy manner to create and sustain new sources of competitive advantage (Grant and Baden-Fuller, 2004).

2.2. Relationship learning

In line with stakeholder theory and the resource-based view (RBV) of the firm, where inter-organizational connections are built on the basis of mutual individual stakeholders' contributions to shared value creation (Haslam, 2004), this study introduces the concept of relationship learning. Within the present social-economic context, organizations deliberately share information and knowledge with suppliers, customers, and other partners with the ultimate goal of mutually enhancing their knowledge bases and competencies for supporting the innovative process.

In our theoretical background, we largely rely on the approach posited by Selnes and Sallis (2003) who were the first to coin this concept and defined it as "a joint activity in which two parties strive to create more value together than they would create individually or with other partners" (p. 86). For this reason, companies struggle to carry out collaborations with specific partners that enable the improvement of future behaviors and increase the benefits associated with such relationships. Cheung, Myers and Mentzer (2011) denote the term as a joint activity between buyer-suppliers in which two parties share information. Selnes and Sallis (2003) consider RL as a multidimensional construct composed of three dimensions: *information sharing, joint sensemaking* and *knowledge integration.* However, we want to focus on sensemaking information because we consider that it is very important to know how the knowledge base of the firm is transmitted.

Normally, the exchange of knowledge within the distinct parties in supply chain cooperation ties represents a relationship-specific component of understanding and cohesion. Nevertheless, the groups might differ in the way in which they grasp and perceive the same information (i.e., sensemaking), or perhaps lack the knowledge required to make sense of it. Then, companies may rely on the use of an array of mechanisms to foster joint sensemaking of knowledge (i.e., face to face communications during visit programs, management meetings, informal or personal networks, project-based and cross-functional teams). Such a set of instruments may guide firms in their cooperative path, creating joint learning areas, and solving operational problems inherent to relationships.

2.3. Green Innovation Performance

Green innovation performance is a type of innovation that tries to reduce or minimize environmental damages. Certainly, green innovation performance is a firm's strategy that offers a great opportunity to meet buyers' requirements while preserving, or at least not damaging the ecosystem (Albort-Morant et al., 2016). Customers across the world are increasingly aiming to buy products and services labeled as "ecological", "environmentally conscious", "eco-friendly" or "green". This way, the "green" tag is a real incentive for firms to develop nonstop innovation, craft new market opportunities and comply with new consumer requests, thus building and enhancing customer capital (Leal-Millán et al., 2016).

In an effort to carry out environmental procedures, companies develop new processes, products, technologies and/or management strategies that are thought out and designed to raise their effectiveness. This work explicitly refers to the definition of green innovation posited by Chen et al. (2006, p. 332), who label it as "hardware or software innovation that 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".

Chang (2011) conceptualizes green innovation as a particular type of innovation that enables a company to improve its corporate image, develop new markets, and to enlarge its competitive advantage while satisfying the stakeholders' environmental protection requests. Likewise, Leenders and Chandra (2013) claim that green innovation entails product or process innovation that deal with technological development aimed at pollution prevention, recycling, waste reprocessing, energy saving, and eco-efficient design. Lately, Hashim et al., (2015) argue that this sort of innovation pursues minimizing organizations' environmental footprint by embracing significant shifts in corporate strategy, product designing methods, productive processes, resources utilization, and waste treatment procedures.

3. Research framework and hypothesis

3.1. The mediating role of relationship learning in the knowledge base-green innovation performance link

Innovation involves the invention and application of new or novel ideas concerning products, services or processes. These days, many firms are being pressed to embrace active strategies oriented at facing the impact exerted by the growing importance of environmental issues. According to Chesbrough (2003), companies should use external and internal ideas to generate successful green innovation processes and products. Hence, the starting point of numerous green innovations might be a partner's ideas and proposals (Koc and Ceylan, 2007).

A firm's set of resources and capabilities are amongst the main sources of competitive advantage and business innovation. Then, firms' knowledge management and organizational learning strategies are to a great extent influenced by its knowledge-related resources and capabilities, such as technical competencies, technological updates, knowledge bases, or the management and storage of organizational know-how. It could be argued that the main driver of knowledge management lies in the firm's knowledge stock, the set of knowledge resources accumulated and the display of knowledge-based capabilities gathered (Leal-Millán et al., 2017).

Knowledge stands as a key strategic resource for a company that intends to sustain environmentally-based competitive innovations. Since knowledge is created and shared throughout the company and across different partners, it has the potential to generate shared value by increasing its ability to react and respond to new and random situations. Hence, the growing concern about the importance of knowledge and learning mechanisms and its further consideration as key resources and capabilities has inspired managers to appreciate and build relationship based on learning strategies.

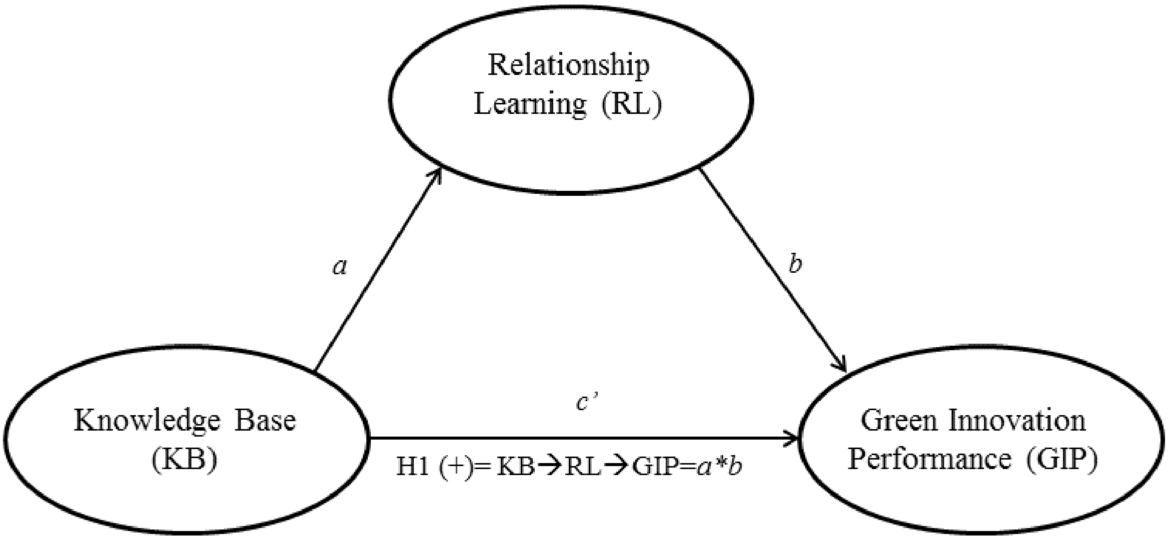
This way, those companies that operate in collaboration with distinct stakeholders, developing relationship-learning processes might see their knowledge bases leveraged by retrieving and absorbing pertinent knowledge from their clients, suppliers, competitors and other partners. Therefore, the establishment of strategic alliances, collaborations or partnerships might effectively improve the basis of green organizational innovativeness, due to the sharing of complementary sets of resources and capabilities (Cheng, 2011). Firms can also rely on the use of joint-ventures, inter-organizational networks, R&D consortium agreements and sectorial clusters or conglomerates in order to become more innovative (Doz et al., 2000). Then, the creation of collaborative networks between organizations and its stakeholders may become a crucial step in this development (Bossink, 2002).

Therefore, cooperation and knowledge exchange with external agents leads to knowledge generation and absorptive capacity enhancement, which in turn may improve the firm's innovation outcomes and overall performance (Akgun, Keskin, Byrne and Aren, 2007). Firms will be urged to develop joint learning-based activities involving their clients, suppliers, intermediates and other partners, in which the different parties share environmental or green-related knowledge (De Marchi, 2012; Leal-Rodríguez et al., 2013).

In sum, developing relationship learning mechanisms may enhance suppliers' understanding of clients' necessities; improve customization through the green-related knowledge exchange between client and supplier, and lead to an increase of the firm's green innovation capacity (Kohtamäki and Partanen, 2016, Leal-Millán et al., 2017). Therefore, the presences of these relational learning mechanisms help the improvement of green innovation performance. Hence, this paper expects that:

H1: Relationship learning mediates the link between the firm's knowledge base and green innovation performance.

Figure 1. Research model



4. Method

4.1. Sample and data collection

This study selects the industry of automotive components manufactures in Spain (ACMS). We have specifically focused on this sector due to the following reasons. Firstly, the Spanish automotive sector occupies the second spot among car manufacturers in Europe and the eighth position worldwide with only 9 vehicle manufactures in Spain –Ford, Renault, Mercedes, Nissan, Renault, Peugeot, Opel, Seat and Citroën. Its main strengths are: a high level of productivity, a high qualification of the labor force, a high investment in R&D, sophisticated machinery, the competitiveness of the components industry and auxiliary industries. Secondly, this sector has the obligation to reduce waste generation as much as possible (Santini et al., 2011) and for this reason companies must comply with strict environmental norms and legislation. Finally, this industry is characterized by the high presence of alliances or cooperative actions between partners. Components manufacturers should provide an appropriate service that satisfies the needs of their main clients –large vehicle manufacturing firms. For example: by designing and producing pieces that facilitate reusing and recycling, the integration of recycled materials, the reduction of residuals, and the establishment of limits in the utilization of dangerous or harmful substances within the production process (Gerrard and Kandlikarb, 2007).

The sample is obtained from a list of firms provided by Sernauto (www.sernauto.es), the Spanish association of automotive components and equipment manufacturers. From the total of 960 companies that make up this sector, we selected a population of 387 corporations that develop green innovation processes and practices. This study utilizes an off-line survey as the data collection instrument. After two efforts, we obtained 112 usable surveys: a 28.94% response rate.

4.2. Measures

The design of the questionnaire instrument is based on the extensive literature review described in Section 2. The study eminently uses previously validated scales, where all the items and responses appear on a seven-point Likert scale ranging from 1 –high disagreement– to 7 –high agreement–. The scale for measuring relationship learning was adapted from Selnes and Sallis (2003). We considered as a measure the joint sensemaking dimension of RL because of it describing pretty much the behavior of the stakeholder in the automotive sector. The knowledge base construct is approached through a five-item scale adapted from Zhou and Li (2012). This scale divides the knowledge base into two dimensions –knowledge breadth and knowledge depth. Finally, in order to measure the green innovation performance construct, we have adapted the eight-item scale proposed by Chen et al. (2006).

4.3. Partial Least Squares

Partial Least Squares Consistent (PLSc) path-modeling is a variance-based structural equation modeling technique (Dijkstra and Henseler, 2015; Henseler et al., 2016). This method allows the combined use of latent variables that represent the concepts grounded in theory and data from manifest variables. Thus, PLSc was used to assess the measurement model –the reliability and validity of the measures–and to estimate the structural model –the relationships modeled between constructs.

The election of the PLSc technique is justified by the subsequent reasons recommend by Henseler et al. (2016): (i) we use latent variables as composites; (ii) the research model has reflective latent variables (Henseler, 2017) that are used to define a state where perceived variables are equally dependent upon another variable which is not itself observed. As the model has reflective variables it will be analyzed using a Model A consistent; (iii) the research model uses non-normal data; (iv) the study employs an exploratory analysis. We utilize the ADANCO 2.0 software in order to test the validity and statistical significance of the measurement and structural models respectively (Henseler and Dijkstra, 2015).

5. Results

Following Henseler et al. (2016), PLSc models are appraised through three phases: (i) determining the global model assessment; (ii) verifying the reliability/validity of the measurement model and, (iii) assessing the significance of the paths (relationships between constructs) within the structural model.

5.1. Global model

The global model assessment implies the utilization of goodness of model fit measures based on means of bootstrap-based tests of the model fit over the least squares and the maximum likelihood and the geodesic discrepancy between the empirical and the model-implied correlation matrix, respectively (Dijkstra & Henseler, 2015).

According to SRMR, the original value yields the cut-off value suggested by Hu and Bentler (1999).

As you can see in Table 1, all the deviations are insignificant because the 95% bootstrap quantiles of the value of the three measures are bigger than the original values (Henseler et al., 2016).

Table 1. Goodness of model fit

Fit measures	Original Value	HI95
SRMR	0.08	0.09
d_{ULS}	0.99	1.27
d_G	0.51	1.21

5.2. Measurement model

The evaluation of the measurement model shows acceptable results. First, all the indicators and dimensions satisfy the requirement of reliability, since all their outer loadings are greater than 0.707 (Table 2). Second, all second-order reflective (superordinate) constructs –RL and GIP– and the first-order construct –GIP– comply with the requisite of construct reliability as their composite reliabilities (CR) and Dijkstra-Henseler's indicator (Rho_A) are over 0.7. Third, Table 3 reveals that all the variables achieve discriminant validity following the HTMT criterion (Henseler, Ringle, & Sarstedt, 2015). Therefore, there is evidence that GIP, RL and KB are distinctive constructs.

Table 2. Measurement model: loadings, construct reliability and discriminant validity

Construct/dimension/ indicator	Loadings	Construct Reliability (CR)	Cronbach's	Average variance
		Dijkstra-Henseler's rho (Pa)	Alpha(α)	Extracted (AVE)
Knowledge Base (KB)		0.829	0.791	0.532
KB1	0.916			
KB2	0.426			
KB3	0.223			
KB4	0.554			
KB5	0.761			
Relationship learning (RL)		0.960	0.958	0.888

RL1	0.963			
RL2	0.915			
RL3	0.8536			
RL4	0.9560			
Green Innovation Performance (GIP)		0.965	0.961	0.787
GIP1	0.924			
GIP2	0.894			
GIP3	0.896			
GIP4	0.744			
GIP5	0.776			
GIP6	0.921			
GIP7	0.958			
GIP8	0.803			

Table 3. Measurement model: discriminant validity

Heterotrait-Monotrait Ratio of Correlations (HTMT)			
	KB	RL	GIP
KB			
RL	0.165		
GIP	0.305	0.659	

5.2. Structural model

Following Hair et al. (2014), a bootstrapping technique (5000 re-samples) is employed in order to generate standard errors and t-statistics that permit the assessment of the statistical significance for the links considered in the two research models. Table 4 includes the main parameters obtained for the model under study in the structural assessment. The adjusted coefficient of determination (R^2) is assumed as the main criterion for the explained variance, which is shown in the dependent construct, as path coefficients are depicted in the distinct models considered. These results endorse that the structural models have acceptable predictive relevance for the endogenous constructs –RL and GIP.

The model comprises the total connection between the knowledge base and green innovation performance. In this case, our results reveal that there does exist support for the total relationship between KB and RL (0.214*; 2.110), KB and GIP (0.197***; 3.787), and RL and GIP (0.620***; 7.78). This case is a necessary, but not sufficient, condition for an indirect effect of KB on GIP to exist through RL (Nitzl, Roldán and Cepeda-Carrión, 2016). Consequently, this research tests whether a × b is also significant. This model also shows how the indirect effect (H1=0 .1329*; 2.027) is significant.

In order to estimate the indirect effect of the knowledge base on green innovation performance, PLS analysis yields percentile 95% bootstrap confidence intervals for the indirect effect. If zero is absent from the interval for an indirect effect this means that this indirect relationship is significantly different from zero with a 95% confidence level.

Our study has a partial mediation (complementary) because the indirect and direct figures are significant. Hence, this result means that RL partially mediates the influence of KB on GIP. The results summarized in Table 4 approve the structural model as being satisfactory.

Table 4. Structural model results

	Original Coefficient	**Model**	**Percentile 95% confidence intervals**
		$R^2_{RL} = 0.037$ $R^2_{GIP} = 0.465$	
a: KB→RL	0.214	0.214*(2.110)	[0.047;0.432] Sig.
c’: KB→GIP	0.329	0.197***(3.787)	[0.191;0.528] Sig.
b: RL→GIP	0.619	0.620***(7.786)	[0.455;0.763] Sig.
H1: KB→RL→GIP (Indir. Effect)	0.133	0.1329*(2.027)	[0.0279; 0.277] Sig.

Notes: t values in parentheses. Bootstrapping 95% confidence intervals bias corrected in square brackets (based on n = 5000 subsamples). ***p b .001; **p b .01; *p b .05 (based on t(4999), one-tailed test). t(0.05, 4999) = 1.645; t(0.01, 4999) = 2.327; t(0.001, 4999)= 3.092; ns = not significant.

6. Discussion and conclusions

Several research studies have recently explored the existence of a direct tie between the knowledge base and green innovation performance (Leal-Rodríguez et al., 2013; Albort-Morant et al., 2016), or the link between relationship learning and green innovation performance (De Marchi and Grandenetti, 2013, Cainelli et al., 2015). However, the mediation of relationship learning in the link between the knowledge base and green innovation performance has not been sufficiently explored until now. Hence, building upon the previous literature, this work develops a research model that explores the role of that mediation.

The results from the empirical analysis reveal that both the total and indirect effects of the knowledge base on green innovation performance are positive and significant. Furthermore, the structural model finds support for the hypothesis stating that a firm's knowledge base has a positive effect on green innovation performance and that this influence is realized by means of the reconfiguration and enhancement of its relationship learning capability – an indirect effect of KB on GIP via RL.

Therefore, a company's knowledge base can impact on the generation of green innovation performance. But the knowledge base could impact better if the companies share and compare information with stakeholders through a process of relationship learning. In summary, this study reflects the central importance of having a strong organizational knowledge base and acquiring and creating new knowledge through relationship learning during firm cooperation to generate green innovation performance.

This study conveys some noteworthy contributions, both for academics and practitioners. In the first place, we shed light upon the conceptualization of the knowledge base, relationship learning and green innovation performance constructs. We understand that green innovation may develop into a remarkable variable that should be taken into account by researchers and executives, since it might perform as a catalyst for organizational performance and attaining competitive advantages. Second, grounded on the literature concerning the knowledge base, relationship learning and green innovation performance, we have proposed a research model that explores the mediation link between these constructs. Third, we empirically test the research model and hypothesis in a sample made up of a total of 112 Spanish automotive components manufacturing firms.

In addition, this study contributes to the literature in the field of resources and capabilities by demonstrating that the existence of firm´s competitive advantages (in its various forms, e.g., effective green innovations) requires not only of a set of powerful resources (such as a broad and deep knowledge base) but also the deploying of certain capabilities (for instance, relationship learning) that develop these resources within a framework of external relations of inter-organizational cooperation and competition.

This study has important practical implications for strategic managers of manufacturing firms who aim to obtain a green knowledge base about the main companies of the automotive sector to improve green innovation performance. The level of green innovation performance in these companies is frequently highly conditioned by a previous accumulation of associated knowledge in its KB.

We provide a theoretical and empirical basis for the further analysis of green innovation performance of firms belonging to the ACMS. In such a context of close cooperation and even competition, ACMS companies may obtain interesting information about the latest environment changes in the sector. Therefore, these companies should establish and reinforce strong ties with their stakeholders, generating in turn a partnership relationship instead of the normal customer-supplier link. Hence, the knowledge base and relationship learning can be among the key resources and capabilities that should be encouraged at the managerial level in order to attain an enhanced green innovation performance. In particular, our results reveal that the fostering of an extensive relationship learning capability (in coopetitive conditions with a broad set of stakeholders and competitors) stresses the effect that a broad and deep knowledge base exerts on the results of green innovation among industrial firms.

With regard to its limitations, the present paper is not without some. First, though this work provides evidence of causality, the analysis does not test causality itself. Second, this research is based on the subjective perceptions of the respondents completing the survey, and to elicit such insights from the interviewees the survey methodology uses a single method. Finally, this work takes place within a specific geographical context (Spain) and an economic sector (equipment and components manufacturing for the automotive industry). For these motives, researchers must be cautious when generalizing these results and conclusions to distinct situations or contexts.

Regarding the implications and limitations derived from the discussion of the results in this study, we suggest the subsequent lines of future research. First, we consider it might be worthy to examine the moderating effect exerted by certain managerial variables that we expect could influence green innovation performance. Second, further research should also contain a longitudinal approach aimed at collecting data belonging to different points of time, which might allow us to verify the hypotheses posited in our research model. Thirdly, it might be interesting to replicate this study within a distinct geographical context or sector, in an attempt to generalize our insights and conclusions.

Finally, we will study the circular relation between knowledge base and relationships learning because we believe that these two variables may complement each other. Moreover, there might be a broader set of important drivers of green innovation performance that could be introduced in future research models.

7. References

Ahuja, G., & Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strategic Management Journal*, *22*(3), 197-220.

Akgun, A. E., Keskin, H., Byrne, J. C., & Aren, S. (2007), Emotional and learning capability and their impact on product innovativeness and firm performance. *Technovation, 27*(9), 501-513.

Albort-Morant, G., Leal-Millán, A., & Cepeda-Carrión, G. (2016). The antecedents of green innovation performance: A model of learning and capabilities. *Journal of Business Research*, *69*(11), 4912-4917.

Bierly, P., & Chakrabarti, A. (1996). Generic knowledge strategies in the U.S. pharmaceutical industry. *Strategic Management Journal*, *17*(1), 123–135.

Bossink, B. A. (2002). The development of co–innovation strategies: stages and interaction patterns in interfirm innovation. *R&D Management*, *32*(4), 311-320.

Cainelli, G., De Marchi, V., & Grandinetti, R. (2015). Does the development of environmental innovation require different resources? Evidence from Spanish manufacturing firms. *Journal of Cleaner Production*, *94*, 211-220.

Chang, C. H. (2011). The influence of corporate environmental ethics on competitive advantage: the mediation role of green innovation, *Journal of Business Ethics, 104*(3), 361-370.

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics, 67*(4), 331–339.

Cheng, J. H. (2011). Inter-organizational relationships and knowledge sharing in green supply chains—Moderating by relational benefits and guanxi. *Transportation Research Part E: Logistics and Transportation Review*, *47*(6), 837-849.

Chesbrough, H. (2003). The logic of open innovation: managing intellectual property. *California Management Review, 45*(3), 33-58.

Cheung, M. S., Myers, M. B., & Mentzer, J. T. (2011). The value of relational learning in global buyer-supplier exchanges: a dyadic perspective and test of the pie-sharing premise. *Strategic Management Journal, 32*(10), 1061-1082.

Chiou, T. Y., Chan, H. K., Lettice, F., & Chung, S. H. (2011). The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transportation Research Part E: Logistics and Transportation Review, 47*(6), 822-836.

De Marchi, V. (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Research Policy, 41*(3), 614-623.

De Marchi, V., & Grandinetti, R. (2013). Knowledge strategies for environmental innovations: the case of Italian manufacturing firms. *Journal of Knowledge Management*, *17*(4), 569-582.

Doz, Y. L., Olk, P. M., & Ring, P. S. (2000). Formation processes of R&D consortia: Which path to take? Where does it lead?. *Strategic Management Journal, 21*(3), 239-266.

Fernandes, C., & Ferreira, J. (2017). Cooperation and coopetition in SME networks: A bibliometric study. In M. Peris- Ortiz & J. J. Ferreira (Eds.): Cooperative and Networking Strategies in Small Business, New York: Springer, 11-29.

Gerrard, J., & Kandlikarb, M. (2007). Is European end-of-life vehicle legislation living up to expectations? Assessing the impact of the ELV Directive on “green” innovation and vehicle recovery. *Journal of Cleaner Production, 15*, 17-27.

Ghobadi, S., & D’Ambra, J. (2012). Knowledge sharing in cross-functional teams: a coopetitive model. *Journal of Knowledge Management, 16*(2): 285–301.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(S2), 109-122.

Grant, R. M., & Baden-Fuller, C. (2004). A knowledge accessing theory of strategic alliances. *Journal of Management Studies, 41*(1), 61-84.

Hair, F., Sarstedt, J., Hopkins, M. L., & Kuppelwieser, G. V. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, *26*(2), 106-121.

Hashim, R., Bock, A. J., & Cooper, S. (2015). The Relationship between Absorptive Capacity and Green Innovation. World Academy of Science, Engineering and Technology, International *Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, *9*(4), 1065-1072.

Haslam, N. (2004). Relational models theory: A contemporary overview (pp. 3-25). Laurence Erlbaum Associates: Mahwah, NJ.

Henseler, J., & Dijkstra, T. K. (2015). ADANCO 2.0. Kleve: composite modeling.

Henseler, J., Hubona, G., & Ray, P. A. (2016). Using PLS path modeling in new technology research: updated guidelines. *Industrial Management & Data Systems*, *116*(1), 2-20.

Henseler, J. (2017). Bridging design and behavioral research with variance-based structural equation modeling. *Journal of Advertising*. DOI: 10.1080/00913367.2017.1281780

Koc, T., & Ceylan, C. (2007). Factors impacting the innovative capacity in large-scale companies. *Technovation*, *27*(3), 105-114.

Kohtamäki, M., & Partanen, J. (2016). Co-creating value from knowledge-intensive business services in manufacturing firms: The moderating role of relationship learning in supplier–customer interactions. *Journal of Business Research*, *69*(7), 2498-2506.

Leal-Millán, A., Albort-Morant, G., Leal-Rodríguez, A., & Ariza-Montes, A. (2017). Relationship learning strategy as a mechanism of network and the effectiveness of green innovation. In Cooperative and Networking Strategies in Small Business (pp. 81-95). Springer International Publishing.

Leal-Millán, A., Roldán, J. L., Leal-Rodríguez, A. L., & Ortega-Gutiérrez, J. (2016). IT and relationship learning in networks as drivers of green innovation and customer capital: Evidence from the automobile sector. *Journal of Knowledge Management*, *20*(3), 1-22.

Leal-Rodríguez, A. L., Roldán, J. L., Leal, A.G., & Ortega-Gutiérrez, J. (2013). Knowledge management, relational learning, and the effectiveness of innovation outcomes. *The Service Industries Journal, 33*(13), 1294–1311.

Leenders, M. A., & Chandra, Y. (2013). Antecedents and consequences of green innovation in the wine industry: the role of channel structure. *Technology Analysis & Strategic Management*, *25*(2), 203-218.

Lettice, F., Wyatt, C., & Evans, S. (2010). Buyer-supplier partnerships for product design and development in the automotive sector: who invests, in what and when?. *International Journal of Production Economics, 127*, 309–319.

Lin, M. J. J., & Chang, C. H. (2009). The positive effect of green relationship learning on green innovation performance: The mediation effect of corporate environmental ethics. In PICMET'09-2009 Portland International Conference on Management of Engineering & Technology (pp. 2341-2348). IEEE.

Loebecke, C., Van Fenema, P., & Powell, P. (1999). Coopetition and Knowledge Transfer. ACM SIGMIS Database - Special issue on information systems: current issues and future changes. 30(2): 14–25.

Nitzl, C., Roldán, J. L., & Cepeda Carrión, G. (2016). Mediation Analysis in Partial Least Squares Path Modeling: Helping Researchers Discuss More Sophisticated Models. *Industrial Management & Data Systems*.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 4–33.

Selnes, F., & Sallis, J. (2003). Promoting relationship learning. *Journal of Marketing*, *67*(1), 80-95.

Spender, J. C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, *17*, 45–63.

Zhou, K. Z., & Wu, F. (2010). Technological capability, strategic flexibility, and product innovation. *Strategic Management Journal, 31*(5), 547 –561.

Zhou, K. Z., & Li, C. B. (2012). How knowledge affects radical innovation: Knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal*, *33* (9), 1090–1102.

CHAPTER 6

Absorbing external environmental knowledge to generate green product and process innovations

CHAPTER 6: Absorbing external environmental knowledge to generate green product and process innovations

Abstract:

This study focuses and develops a research model that links the two dimensions of absorptive capacity (PACAP and RACAP) with green product innovation performance (GIPr) and green process innovation performance (GIPc). The study's contribution to the literature is to explain as companies need to acquire, assimilate and transform external knowledge to develop new green innovation performance. The present study uses a sample of 112 firms from the Spanish automotive components manufacturing sector. The results obtained by Partial Least Squares (PLS-SEM) analysis, reveals that, potential and realized absorptive capacity are positively related to both green product innovation performance and green process innovation performance.

Keywords: Potential absorptive capacity, realized absorptive capacity, green product innovation performance, green process innovation performance, partial least squares

1. Introduction

Nowadays, companies are requested to comply with the environmental regulations established by Kyoto Protocol, Montreal Convention, Waste Electronics and Electrical Equipment (WEEE) among others. The environmental protection concept has gained attention in the management agenda due to the significant environmental awareness increase experienced by society in last decades. This has contributed to set the basis of green innovation strategies through which firms must develop green-related innovations aimed at to mitigating or avoiding environmental damage (Albort-Morant et al., 2016). In this sense, companies that proactively embrace green innovation strategies might be able to encompass sustainable competitive advantages (Buhl et al., 2016).

The term green innovation performance, as defined by Lai et al. (2003) is the outcome derived from all the innovative environmental management efforts in line with the firm's wish to satisfy environmental protection requirements. Later, Chen, Lai and Wen (2006) defined this term as "hardware or software innovation that 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" (p. 332). This study divides the green innovation construct into: 1) green product innovation performance (GIPr) and 2) green process innovation performance (GIPc). On the one hand, green product innovation performance is focused on energy-saying, pollution-prevention, waste recycling, not toxic, or green prodcut designs. To this aim, companies choose those materials that produce the least amount of pollution, consume the least amount of energy and resources, and ellaborate a product which is easy to recylce, reuse and descompose. On the other hand, green process innovation performance deals with the firm's endeavor on the implementation and development of greener process, attempting that the company's manufacturing processes should reduce the emission of hazardous substances or waste, recycle waste and emission that allow them to be treated and re-used, reduce the consumption of water, electricity, coal or oil; and optimize the use of raw materials (Lai et al., 2003).

Current research sustains the emergence of a firm's absorptive capacity (ACAP) as a fundamental dynamic capability for improving innovation in organizations (Fosfuri and Tribo, 2008). The literature in the field of organizational learning reports that organizations that possess relevant prior knowledge are likely to have a better understanding of new technology that can generate new ideas and develop new products, services and processes (Tsai, 2001). Specifially, absorptive capacity is an important driver of green innovation adoption (Hashim et al., 2015) because it allows firms to enhance their ability to comprehend, connect, combine, identify and apply environmental knowledge.

Organizational absorptive capacity (ACAP), or the ability of organizations to create knowledge, is frequently cited as a requirement for innovation (Cohen and Levinthal, 1990). ACAP is conceptualized as a multidimensional construct that creates innovation-related value for the organization. At first-order level of analysis, includes a set of 4 capabilities: i) acquisition; ii) assimilation; iii) transformation; and iv) exploitation. The two first constitute an organization's potential absorptive capacity (PACAP). And the other two dimensions constitute an organization's realized absorptive capacity (RACAP) (Zahra and George, 2002). Therefore, PACAP embodies the integration of external knowledge within the firm's knowledge repository, while RACAP represents its combination, utilization and application (Lane et al., 2006; Setia and Patel, 2013). While these specific multidimensional levels of ACAP have advanced our understanding of the concept (Auguste et al., 2010; Noblet et al., 2011) there is in particular a lack of empirical research specifically considering these dimensions (Mariano and Walter, 2015).

In this study we will adopt Zahra and George (2002) conceptualization of absorptive capacity because we want to offer an empirically tested model to explain the enhancement of the two dimensions of absorptive capacity (PACAP and RACAP) with the two dimensions of green innovation performance (GIPc and GIPr). Specially, we intend to provide an answer to the following research questions: (i) How does potential absorptive capacity influence realized absorptive capacity? (ii) How does a firm's potential absorptive capacity influence the creation of firm's green innovation through processes and products? (iii) How does a firm's realized absorptive capacity influence the creation of firm's green innovation through processes and products? Thus, we seek to reach a better understanding of the influential relations between PACAP, RACAP, GIPr and GIPc. Therefore, our aim is build a theoretical and empirical contribution to the literature regarding the conceptualization and measurement, and interrelationships between these variables.

The methodology employed in this work involves a quantitative empirical survey of SMEs from the Spanish automotive components manufacturing sector (ACMS), based on a final random sample comprising 112 companies. We used Partial

Least Squares (PLS), a variance-based structural equation modeling to test the hypotheses proposed in our research model (Henseler et al., 2009).

The following section reviews the scientific literature concerning the links between potential absorptive capacity, realized absorptive capacity, green innovation product performance and green innovation process performance, and subsequently posits the research model and hypotheses. Then this study introduces the research methodology and presents the PLS results together with insights from mediation analysis. The final section of the paper discusses the results and suggests various implications and limitations before concluding the article.

2. Theoretical background

2.1. Absorptive capacity

Referring to Cohen and Levinthal (1990) seminal work, the term Absorptive capacity (ACAP) can be defined as the firm's ability to value, assimilate, and apply new knowledge. Meanwhile, Kim (1997a, 1997b) defined it as the firm's capacity of learning and resolving difficulties. A later study developed by Zahra and George (2002) supposed an important reconceptualization of absorptive capacity. In this study, we will focus on the theory proposed by Zahra and George (2002) that distinguish between two dimensions of ACAP –PACAP and RACAP–. These authors also suggested to distinguish among four subsets that compose a firm's ACAP: i) acquisition, ii) assimilation, iii) transformation and iv) exploitation. A definition of these four capabilities is offered in the following paragraphs.

i) Acquisition capacity: this term refers to the company's identifycation and acquisition of valuable external knowledge. This is consitent with Cohen and Levinthal's (1990, p. 128) view of the process of identification and evaluation of external knowledge. As they theorized as the ability to evaluate and utilize previous knowledge to identify, assimilate and apply new information value.

ii) Assimilation capacity: this concept has come to be used to refer to firm's habits, methods, processes and routines that lead them to an effective assessment, processing and understanding of the information captured from external sources (Kim 1997a). This capability is deeply rooted on individual's understanding and knowledge interpretation. This way, knowledge assimilation is based on the firm's ability to grasp new external knowledge and make sense of it.

iii) Transformation capacity: this term refers to the combination of the newly acquired external knowledge and the firm's prior related knowledge. Concretely, Zahra and George (2002, p. 190) suggest that this dimension "denotes a firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge". This phase is considered the most relevant. This is achieved by adding or deleting knowledge or by the simple interpretation of knowledge in a different way.

iv) Explotation capacity: this concept is defined "as an organizational capability that is based on the routines that allow firms to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations" (Zahra and George, 2002, p.190). Cohen and Levinthal's (1990) use the term "explotation" to refer to the application of new external knowledge to commercial ends. Therefore, if all the other phases do not lead to knowledge exploitation, they will not have proven to be very useful.

2.2. Green innovation performance

With the increase of environmental concerns expressed by customers, manufacturers and product designers create designs that are less polluting or harmful for the environment. Therefore, green innovation contains all type of innovations that donate to the generation of products, services or processes to decrease the damage, effect and decline of the environment, at the same time that enhances the use of natural resources.

Authors like Hart (1995) or Porter and Van der Linde (1995) suggest that green innovation may possibly raise companies' productivity and maximize their exercise of resources becoming consequently more competitive since the improvement and sustainment of competitive advantages rooted in the corporate image improvement and the development of new markets while gratifying the requirement of environmental protection (Lai et al., 2003, Chang, 2011).

Recently, Leal Millan et al. (2016) define green innovation is "a strategic need for firms and it offers a great opportunity for meeting buyers' wishes without harming the environment" (p. 448). Hence, the conceptualization of green innovation has stimulated from more resources-oriented descriptions to a more comprehensive framework that incorporates the firm's compliance with the stakeholders' green requirements and demands.

Numerous authoras as Klassen and Whybank (1999), Chen et al. (2006); Tseng et al. (2012) among other have distinguished among several typologies of green innovation: product, processes, technological and managerial. However, our study focuses on green product innovation and green process innovation. Chen et al.(2006); or Chang (2011) difference green innovation into green product innovation and green process innovation.

These authors clarify the process of innovation as a process that adapts the design of an existing product that lets reducing the harmful impact on the environment. This adapts the production process of the company during the whole process of acquisition, production and distribution of the products. And the product innovation is defined as the introduction of novel products and services that do not produce any contamination or is minimal negative consequences, using products and biodegradable materials and are efficient in the use of energy, water or any other natural resource.

2.3. The link between realized absorptive capacity (RACAP) with the firm's green process and product innovation performance

Chen et al. (2006) define green innovation as that sort of innovation that is aimed at the enhancement of a firm's environmental management performance, in order to satisfy the requirement of environmental protection, and this way enabling business to increase resource productivity through green innovation to make up with the environmental costs. The same authors explain that green innovation performance might consist of either green products or green processes carried out. Thereby, green innovation performance can create or enhance value for the firm through the development of more environmentally innovative products or processes. According to Fiol (1996), the prior accumulation of knowledge fosters the firm's potential to produce innovation outcomes. The process of applying new knowledge in order to obtain new products, services or processes usually generates innovation outcomes, such as green innovation performance.

Cohen and Levinthal (1990) introduced the concept of absorptive capacity (ACAP) to describe the firms' ability to value, assimilate, and apply new knowledge. Though there exists an extensive literature about ACAP, this topic only stimulates significant interest within the academic community in light of Zahra and George (2002) conceptualization. The roots of this reconceptualization can be found in the abstract distinction between potential absorptive capacities (PACAP) and realized absorptive capacity (RACAP). Our study is consistent with Zahra and George's (2002) view, which suggests that ACAP comprehends four different but complementary capabilities, namely acquisition, assimilation, transformation, and exploitation. In accordance with their view, PACAP and RACAP involve different capabilities. On the one hand, PACAP involves the knowledge acquisition and assimilation capabilities, which make the firm open to acquire and assimilate new externally rooted knowledge (Lane and Lubatkin, 1998). Conversely, RACAP deals with the firm's knowledge transforming and exploiting capabilities. In this vein, according to Cepeda-Carrión et al. (2012), PACAP and RACAP are essentially distinct concepts, and consequently may draw on different objectives, structures and strategies. These diverse capabilities help the organization are considered to attain a competitive advantage that may lead to superior performance (Barney, 1991).

Following Cohen and Levinthal's (1990, p. 128) reasoning –"the ability to evaluate and utilize outside knowledge is largely a function of the level of prior related knowledge. […] Prior knowledge confers an ability to recognize the value of new information, to assimilate it, and to apply it to commercial ends"–, we posit that green knowledge acquisition deals with a company's capability of identifying and acquiring external environmental knowledge that is critical to its green practices.

Knowledge assimilation is composed by the firm's routines and processes that allow it to analyze processes, interpret, and understand the information obtained from external sources (Kim, 1997a). This second dimension of ACAP consists on the interpretation and understanding of individuals' knowledge. This stage of ACAP approaches the individual level more than the collective one. Specially, knowledge assimilation describes the capacity of understanding new external knowledge and linking it with the prior environmental knowledge base.

Zahra and George (2002, p.190) explain transformation capacity as "a firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge". In this case, transformation stands as the internalization of new external knowledge about environmental practices in existing firm's products and processes.

The last phase has been traditionally considered as the most important one, since exploitation comprises the organization's capability to refine, extend or leverage its existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations and procedures (Zahra and George, 2002).

PACAP includes the acquisition and assimilation capabilities to obtain external environment knowledge. However, obtaining this knowledge does not guarantee the operation of the same. In a second stage, the phases of transformation and exploitation that shape the RACAP dimension will serve to reflect the environmental knowledge previously acquired. Therefore, PACAP and RACAP are different concepts that involve very different strategies and structures. While PACAP requires change, flexibility and creativity, RACAP requires control and stability.

Beckenbach and Daskalakis (2003) suggest that the novelty creation process is composed of two stages, called "invention" and "innovation". On the one hand, invention is associated to the creation of a conceptual novelty (i.e., the creation of new ideas or concepts to be applied in a specific business context). This conceptual novelty is essentially rooted in the individuals' tacit knowledge (Nonaka and Takeuchi, 1995). On the other hand, the innovation phase incorporates the creation of an instrumental originality. This is the process of using the newly-created knowledge and representing it in various forms. The success of this phase depends on the firm's capacity to absorb environmental knowledge and combine it with its own knowledge base.

Several studies posit that the ability to exploit external knowledge effectively constitutes a critical factor for companies with an interest in enhancing innovation outcomes and firm performance (Cohen and Leinthal, 1990; Zahra and George, 2002; Van Den Bosch et al., 2003; Lane et al., 2006; Lichtenthaler, 2009; Leal-Rodríguez, 2014). Besides, only a few works have studied the relationship between absorptive capacity and green innovation (Gluch et al., 2009; Chen et al., 2014; Hashim, 2015). However, there is in particular a lack of empirical research specifically considering the links between these constructs' dimensions.

Hence, a company's absorptive capacity is the quality which permits knowledge to be transformed into new products or services and processes to provide green innovation performance. On the one hand, it is very important that the companies absorb external knowledge about environmental issues, which might serve to reduce or mitigate pollution in their processes of innovation. For example: multiple companies may require to absorb knowledge about the measures and international standards set out in the Kyoto Protocol or the norms that they must meet in order to obtain the ISO 14001. This new knowledge acquired in combination with its knowledge base will allow companies to include innovations in their processes and strategies.

On the other hand, green product innovation performance consists in product improvements related to environmental innovation, and green processes innovation performance involves process improvements related to waste and oils recycling, prevention of pollution, etc.,(Chen, 2008). Thus, green products are designed to provide a reliable solution for environmentally-conscious consumers seeking affordable and high quality eco-friendly products (Chen et al., 2015). For this reason, companies should absorb external environmental knowledge in order to satisfy the environmental protection requirements and to design new greener products or improve the existing ones.

Hence, this study asserts that RACAP positively influences green product and process innovation performance and posits the following hypotheses:

H1: Realized absorptive capacity (RACAP) is positively related to a firm's green product innovation performance (GIPr)

H2: Realized absorptive capacity (RACAP) is positively related to a firm's green process innovation performance (GIPc).

2.4. The link between potential absorptive capacity and realized absorptive capacity

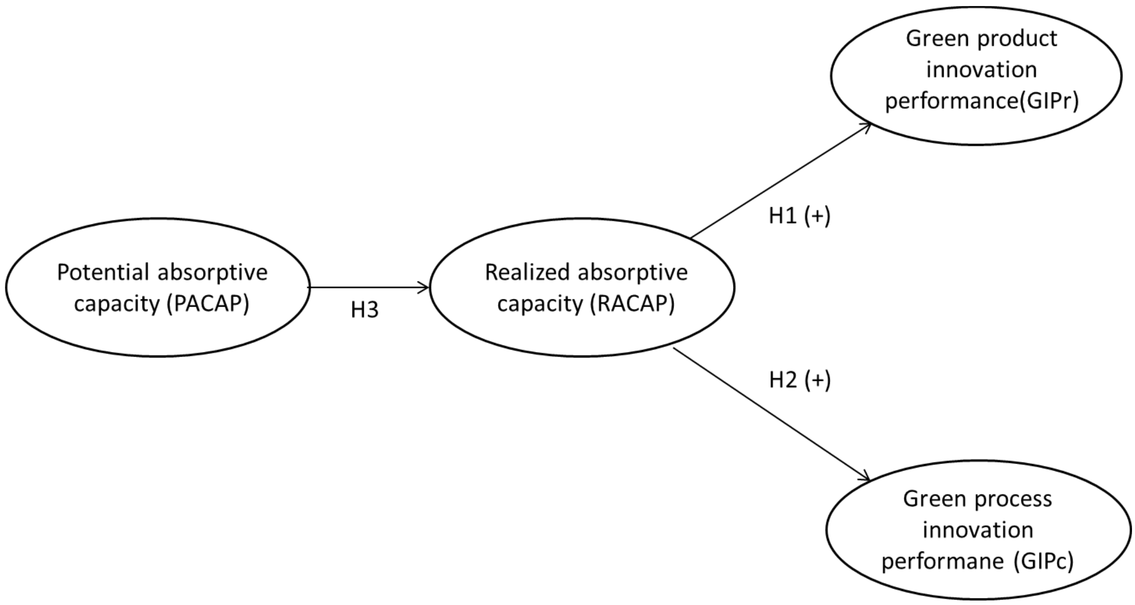
The four capabilities identified by Zahra and George (2002) are distributed between the two constructs or subsections of ACAP. While potential absorptive capacity (PACAP) centers on knowledge acquisition and assimilation, realized capacity (RACAP) focuses on knowledge transformation and exploitation. According to Lee and Wu (2010, p. 124) "Knowledge alone is not enough. A firm needs to have tools to exploit and appropriate this knowledge embedded in new organizational innovations". It means that knowledge acquisition and assimilation can occur, but this does not guarantee that it will be efficiently transformed and exploited by the firm.

To sum up, the main idea of Zahra and George's thinking is that PACAP and RACAP concepts are complementary, in other words, PACAP and RACAP are both necessary for the effective absorption of external knowledge. According to these authors, a firm may have the capability to acquire external knowledge, but it does not guarantee the exploitation of this knowledge.

On the other hand, a firm may have the capacity to influence and exploit knowledge, but is not able to effectively acquire it. Hence, PACAP and RACAP have different roles yet their impact is not isolated, but rather matching. Both subsets of absorptive capacity coexist and participate in the improvement of firm performance. This reasoning lead them to rethink the concept of ACAP. Considering and integrating all the arguments stated above, we propose the third hypothesis. The research framework is shown in Figure 1.

H3: Potential absoptive capacity (PACAP) is positively related to realized absorptive capacity (RACAP)

Figure 1. Research model and hypotheses



3. Method

3.1. Data collection and sample

Bearing in mind the proposed research objectives, a specific industry with a high level of adaptation and creation of green innovation has been selected. The sector of automotive component manufacturers in Spain has specifically been chosen for the following reasons. Firstly, the Spanish automotive sector occupies the 2nd spot among car manufacturers in Europe and the 8th position in the global scenario, uniquely accounting with 9 vehicle manufactures in Spain (Anfac, 2015). Its main strengths are: high level of productivity, qualification of the labor force, investment in R&D, modernization of the machinery, and competitiveness of components and auxiliary industries. Second, the sector has the obligation of reducing waste generation as much as possible. For this purpose, companies must comply with the environmental legislation. Finally, this industry is characterized by alliances or cooperative actions with their stakeholders. The Spanish components manufacturing firms should provide a service appropriate to needs and requirements posited by the main vehicles manufacturing companies. For instance: reducing residual generation, limiting the use of hazardous substances in their products and processes, designing and producing enhanced pieces that facilitate its reustilization and recycle, and developing the integration of recycled materials (Gerrard and Kandlikarb, 2007).

The sample comes from a list of Sernauto (www.sernauto.es), the Spanish association of automotive equipment and components manufacturers. From the total of 960 companies gathered by this association, we identified 387 companies who met our selection criteria (i.e., to channel their operations by means of the use of project teams, to make a widespread use of external knowledge, and the maintaining of strong relationships of interdependence in supply chains). After two mailing efforts we obtained 112 usable surveys returned (a 28.94% response rte). This lower-than expected response rate might be explained because these questionnaires were answered by top executives.

3.2. Measures

The questionnaire was designed on the basis of the literature review described in the article. The study uses validated scales from the literature, where the items and responses were on a seven-point Likert scale ranging from high disagreement to high agreement to measure the questionnaire items. The items for measuring ACAP have been validated and used by Jansen et al. (2005) and Cepeda-Carrión et al. (2012) with nine items assessing the intensity and direction of the efforts expended in acquiring and assimilating new external knowledge (PACAP). Besides, RACAP includes the transformation and exploitation of new external knowledge. Cepeda-Carrión et al.

(2012) measured this construct with a total of twelve items that assess the extent to which firms are able to transform and exploit the newly-acquired knowledge. For measuring Green product and process innovation performance (GIPr and GIPc) this study adapts a scale proposed by Chen et al. (2006) which operationalizes this construct through eight items. The first four items describe green product innovation, while the four latest contribute to measure green process innovations. The four-item measurement instrument developed to evaluate green product innovation performance are: (i) your company chooses the materials of the products that produce the least amount of pollution for conducting the product development or design; (ii) your company chooses the materials products that produce the least amount of energy and resources for conducting the product development or design; (iii) your company uses the fewest amount of materials to comprise their products for conducting the product development or design; (iv) your company would circumspectly evaluate whether their products are easy to recycle, reuse, and decompose for conducting the product development or design. The four items measuring green process innovation performance are: (i) the manufacturing process of your company effectively reduces the emission of hazardous substances or wastes; (ii) the manufacturing process of your company effectively recycles wastes and emission that can be treated and re-used; (iii) the manufacturing process of your company effectively reduces the consumption of water, electricity, coal, or oil; (iv) the manufacturing process of your company effectively reduces the use of raw materials.

3.3. Data analysis

Our research model and hypotheses have been tested using Partial Least Squares (PLS), a variance-based structural equation modeling (Henseler et al., 2009). PLS allows the use of latent variables that represent the concepts posited in theory, and data from manifest variables. These variables are used as input for the statistical analysis that arrange for evidence on the relations between the latent variables. PLS was therefore used to assess the measurement model –the reliability and validity of the constructs' measures– and to estimate the structural model –the relationships modeled between constructs–. The use of PLS is justified by the following reasons of Rigdon (2016): (ii) the research model has variables reflective that they are used to define a state where perceived variables are equally dependent upon another variable which is not itself observed. As the model has reflective variables will be analyzed using a Model A consistent; (iii) the research model use a non-normal data; (iv) the study utilize an exploratory analysis. This study uses ADANCO 2.0 software (Henseler and Dijkstra, 2015) for the PLS analysis.

4. Results

4.1. Measurement model

Measurement model involves the assessing for reliability and validity. The measurement model is completely satisfactory (tables 1 and 2). First, the indicators and dimensions satisfy the requirement of individual item reliability, because their loadings are greater than 0.707. Second, all multidimensional constructs and dimensions meet the requisite of construct reliability, because their composite reliabilities, measured through the Dijstra-Henseler's indicator are greater than 0.7. Third, latent variables attain convergent validiy because their average variance extracted (AVE) measures are over the 0.5 level. Lastly, table 2 shows that all variables achieve discriminant validity following the Heterotrait-monotrait (HTMT) criterion. The HTMT ratio of correlations evaluates the average of the Heterotrait Heteromethod correlations. Several authors suggest a threshold level of HTMT of 0.85 whereas others propose a value of 0.90 (Henseler et al., 2015). In this case, we can observe that the constructs of GIPr and GIPc are highly correlated, since its value is superior to the threshold level of the HTMT80 and HTMT95.Therefore, there is evidence that A and B are not distinctive constructs.

Table 1. Measurement model: loadings, construct reliability and discriminant validity

Construct/dimension/ indicator	Loadings	Construct Reliability (CR)	Cronbachs	Average variance
		Dijstra-Henseler's rho (Pa)	Alpha(α)	Extracted (AVE)
Potential Absorptive capacity (PACAP)		0.9588	0.9490	0.7571
PACAP1	0.9842			
PACAP2	0.8580			
PACAP3	0.6071			
PACAP5	0.8678			
PACAP7	0.9144			
PACAP8	0.9380			

Realized Absorptive capacity (RACAP)		0.9630	0.9575	0.7183
RACAP1	0.9349			
RACAP3	0.8045			
RACAP4	0.9010			
RACAP5	0.7441			
RACAP6	0.9872			
RACAP7	0.8984			
RACAP9	0.6750			
RACAP10	0.8422			
RACAP11	0.7947			
Green Product Innovation Performance (GIPr)		0.9364	0.9289	0.8174
GIPr1	0.9868			
GIPr2	0.8794			
GIPr3	0.8398			
Green Process Innovation Performance (GIPc)		0.9284	0.9250	0.7546
GIPc1	0.9313			
GIPc2	0.8040			
GIPc3	0.9159			
GIPc4	0.8159			

Table 2. Measurement model: discriminant validity

	Heterotrait-Monotrait Ratio (HTMT)			
	GIPr	GIPc	PACAP	RACAP
GIPr				
GIPc	*1.0028*			
PACAP	0.1905	0.2125		
RACAP	0.4418	0.5123	0.2691	

4.2. Structural model

The algebraic sign, magnitude and significance of the structural path coefficients and the adjusted coefficient of determination (R^2) values for predictive relevance allow an evaluation of the structural model (table 3).

Following Hair et al. (2014) the operation of bootstrapping technique use 5000 re-samples, in order to generate the standard errors and t-values (t-statistics), which allow us to check the significance statistics of the relationship hypothesized within the proposed models.

The three hypothesis of the model are significant. The model describes a positive and significant effect of RACAP on GIPr (path coefficient=0.4913; t-value=5.21080.8917) and GIPc (path coefficient=0.4221; t-value=4.2185), and the link between PACAP on RACAP (H3) (path coefficient=0.2728; t-value=2.3544). The three hypotheses are significant. However, the hypothesis three is less significant than the other hypotheses which link RACAP and GIPr and GIPc.

Specifically, we applied a percentile approach,which has the advantage of being completely distribution free (Chin, 2010). Boostrap confidence interval to the 95% for the indirect effect are always greater than zero but direct effect of PACAP and GIPr and GIPc are negative and not significant. Hence, RACAP mediates the relationship between PACAP and GIPr and GIPc.

The results summarized in table 3 confirm that structural model has satisfactory has a full mediation because the indirect effect is significant but the direct effect is not significant (Nitzl, Roldán and Cepeda-Carrión, 2016).

Table 3. Structural model results

	Original Coefficient	**Model**	**Percentile 95% confidence intervals**
		$R^2_{RACAP} = 0.0744$ $R^2_{GIPr} = 0.2693$ $R^2_{GIPc} = 0.2032$	
RACAP→GIPr (H1)	0.4913	0.4913***(5.2108)	[0.3112;0.6851] Sig.
PACAP→ GIPr (Direct effect)	0.0802	0.2142^{ns}(0.8917)	[-0.0971;0.2447] Non Sig.
PACAP→RACAP→GIPr (Indir. Effect)	0.1340	0.1340*(1.9208)	[0.0291;0.2950] Sig.
RACAP→GIPc (H2)	0.4221	0.4221***(4.2185)	[0.2372;0.6228] Sig.
PACAP→GIPc (Direct effect)	0.0806	0.0806^{ns}(0.8917)	[-0.1159;0.2534] Non Sig.
PACAP→RACAP→GIPc (Indir. Effect)	0.1151	0.1151*(1.7595)	[0.0240;0.2679] Sig.
PACAP→RACAP (H3)	0.2728	0.2728**(2.3544)	[0.0648;0.5076] Sig.

Notes: PACAP: Potential absorptive capacity; RACAP: Realized absorptive capacity; GIPr: Green product innovation performance; GIPc: Green process innovation performance. t values in parentheses: t(0.05, 4999) = 1.645; t(0.01, 4999) = 2.327; t(0.001, 4999) = 3.092. * p < 0.05. ** p< 0.01. *** p< 0.001.

5. Discussion

Currently, firms are in need of all that information that can be used to facilitate their engagement in innovation activities such as green innovation. This type of innovation requires new knowledge to be assimilated and transformed within the organization (Horden et al., 2008). Thus, absorptive capacity could be seen as playing an key role in inducing a firm's intention to implement green innovation practices (Hashim et al., 2015), because it applies new knowledge for the attainment of products, services or processes that involve significant improvements or novelty with respect to existing ones (Leal-Rodríguez and Albort-Morant, 2015). Plenty of research studies have argued the existence of a direct link between absorptive capacity and green innovation (Chen et al., 2014; Hashim et al., 2015). However, the links between absorptive capacity and green product and process innovation performance have been scarcely explored. There are not studies that analyse the relationship between the two dimensions of absorptive capacity and green product and process innovation. Hence, building upon the previous literature, this paper develops a research model that links these constructs.

The empirical results of this study suggest that potential and realized absorptive capacity are positively related to both green product innovation performance and green process innovation performance. Moreover, realized absorptive capacity plays a mediator role between potential absorptive capacity and green process and product innovation performance. It explains that organizations cannot exploit external knowledge without previously having acquired and assimilated it, which suggests that PACAP precedes RACAP (Zahra and george, 2002). When higher probability to interpret new knowledge (PACAP), an organization will be more proactive in the explotation of new opportunities that arise in the organization's environment (RACAP). Therefore, PACAP can also provide an incentive for increasing RACAP.

The article makes several theoretical implications. First, we study the effect of PACAP and RACAP on GIPr and GIPc. Second, we test how the PACAP and RACAP dimensions affect each of the types of green innovation. To this aim, we use a survey research with a sample of 112 Spanish firms belonging to the automotive equipment and components manufacturers sector. Finally, our mediation model provides practical steps for managers interested in knowing how potential and realized absorptive capacity generates green innovation performance in their company.

The managerial and practical implications are strong. In this line, we purpose to focus the importance of absorptive capacity (ACAP) on green process and product innovation performance (GIPr and GIPc). Highlight the importance of transform and exploit the knowledge acquired to obtain green innovation performance. Companies may not generate green innovation performance only with the acquisition of knowledge. It should be adapted and transformed to the circumstances of each company and sector.

The present study recognizes a series of limitations in its results and conclusions. First, we were able to provide just a snapshot of ongoing processes.

Consequently, we were unable to investigate the intricacies of the processes and capabilities over time. Second, another limitation is determined by the technique used for the proposed model: structural equations, which assume a linearity of relationships between latent variables. Third, the model of this study does not capture possible moderating effects of environmental turbulence or the effect of control variables.

Fourth, the limitations of using sectorial characteristics, while having the advantage of allowing the network to be analyzed at a global level, show little cohesion.

Finally, the obtaining of green product and process innovation performance depend on the characteristics of the empirical context that is analyzed. For future researchers, we are planning to examine the moderating effect of environmental variables that we expect might influence the results. Also, it might be then interesting to change this particular geographical context (Spain) or this specific sector (ACMS) in further studies, in an attempt of generalizing our insights and conclusions.

6. References

Anfac (2015). Annual memory 2015. http://www.anfac.com/documents/tmp/MemoriaANFAC2015.pdf

Albort-Morant, G., Leal-Millán, A., & Cepeda-Carrión, G. (2016). The antecedents of green innovation performance: A model of learning and capabilities. *Journal of Business Research, 69*(11), 4912-4917.

Auguste, M. S. C., Jashapara, A., & Bernroider, E. (2010). Exploring the perceived influence of new knowledge on absorptive capacity in a public sector organisation. José-Rodrigo Córdoba School of Management, Royal Holloway University of London, 6.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Beckenbach, F., & Daskalakis, M. (2013). Invention and Innovation as Creative Problem-Solving Activities (pp. 1118-1131). Springer New York.

Buhl, A., Blazejewski, S., & Dittmer, F. (2016). The More, the Merrier: Why and How Employee-Driven Eco-Innovation Enhances Environmental and Competitive Advantage. *Sustainability, 8*(9), 946.

Chang, C. H. (2011). The influence of corporate environmental ethics on competitive advantage: the mediation role of green innovation. *Journal of Business Ethics, 104*(3), 361-370.

Cepeda-Carrión, G., Gabriel Cegarra-Navarro, J., & Leal-Millán, A. G. (2012). Finding the hospital-in-the-home units' innovativeness. *Management Decision, 50*(9), 1596-1617.

Chen, Y. S. (2008). The driver of green innovation and green image–green core competence. *Journal of Business Ethics, 81*(3), 531-543.

Chen, Y. S., Chang, C. H., & Lin, Y. H. (2014). The Determinants of green radical and incremental innovation performance: Green shared vision, green absorptive capacity, and green organizational ambidexterity. *Sustainability, 6*(11), 7787-7806.

Chen, Y. S., Lai, S. B., & Wen, C. T. (2006). The influence of green innovation performance on corporate advantage in Taiwan. *Journal of Business Ethics, 67*(4), 331-339.

Chen, Y. S., Lin, Y. H., Lin, C. Y., & Chang, C. W. (2015). Enhancing green absorptive capacity, green dynamic capacities and green service innovation to improve firm performance: an analysis of structural equation modeling (SEM). *Sustainability*, *7*(11), 15674-15692.

Chin, W. W. (2010). How to write up and report PLS analyses. In Handbook of partial least squares (pp. 655-690). Springer Berlin Heidelberg.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152.

Fiol, C. M. (1996). Squeezing harder doesn't always work: Continuing the search for consistency in innovation research. *Academy of Management Review, 21*(4), 1012-1021.

Fosfuri, A., & Tribó, J. A. (2008). Exploring the antecedents of potential absorptive capacity and its impact on innovation performance. *Omega*, *36*(2), 173-187.

Gerrard, J., & Kandlikar, M. (2007). Is European end-of-life vehicle legislation living up to expectations? Assessing the impact of the ELV Directive on 'green'innovation and vehicle recovery. *Journal of Cleaner Production*, *15*(1), 17-27.

Gluch, P., Gustafsson, M., & Thuvander, L. (2009). An absorptive capacity model for green innovation and performance in the construction industry. *Construction Management and Economics*, *27*(5), 451-464.

Hair Jr, J., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. (2014). Partial least squares structural equation modeling (PLS-SEM) An emerging tool in business research. *European Business Review*, *26*(2), 106-121.

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review*, *20*(4), 986-1014.

Hashim, R., Bock, A. J., & Cooper, S. (2015). The Relationship between Absorptive Capacity and Green Innovation. World Academy of Science, Engineering and

Technology. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, *9*(4), 1065-1072.

Henseler, J., & Dijkstra, T. K. (2015). ADANCO 2.0. Composite Modeling, Kleve, available at: www. compositemodeling. com (accessed December 14, 2015).

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the *Academy of Marketing Science, 43*(1), 115-135.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In New challenges to international marketing (pp. 277-319). Emerald Group Publishing Limited.

Hordern, T., Borjesson, S., & Elmquist, M. (2008). Managing green innovation present findings. Center for Business Innovation Working Paper Series, (10).

Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W. (2005). Managing potential and realized absorptive capacity: how do organizational antecedents matter?. *Academy of Management Journal*, *48*(6), 999-1015.

Kim, L. (1997a). The dynamics of Samsung's technological learning in semiconductors. *California Management Review, 39*(3), 86-100.

Kim, L. (1997b). Imitation to innovation: The dynamics of Korea's technological learning. Harvard Business Press.

Klassen, R. D., & Whybark, D. C. (1999). The impact of environmental technologies on manufacturing performance. *Academy of Management journal, 42*(6), 599-615.

Lai, S. B., Wen, C. T., & Chen, Y. S. (2003). The exploration of the relationship between the environmental pressure and the corporate competitive advantage. In 2003 CSMOT Academic Conference. National Chiao Tung University, Hsin-Chu.

Lane, P. J., & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *Strategic Management Journal,* 461-477.

Lane, P. J., Koka, B. R., & Pathak, S. (2006). The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy of Management Review, 31*(4), 833-863.

Leal-Rodríguez, A. L., & Albort-Morant, G. (2015). Capacidad de absorción del conocimiento y resultados de la innovación: un estudio empírico en empresas españolas del sector de la automoción-DOI: 10.5102/un. gti. v5i2. 3618. *Universitas: Gestão e TI*, *5*(2).

Leal-Rodríguez, A. L., Roldán, J. L., Ariza-Montes, J. A., & Leal-Millán, A. (2014). From potential absorptive capacity to innovation outcomes in project teams: The conditional mediating role of the realized absorptive capacity in a relational learning context. *International Journal of Project Management*, *32*(6), 894-907.

Leal-Millán, A., Roldán, J.L., Leal-Rodríguez, A.L., & Ortega-Gutiérrez, J. (2016). IT and relationship learning in networks as drivers of green innovation and customer capital: evidence from the automobile sector. *Journal of Knowledge Management*, *20*(3), 444– 464.

Lee, C. Y., & Wu, F. C. (2010). Factors affecting knowledge transfer and absorptive capacity in multinational corporations. *The Journal of International Management Studies*, *5*(2), 118-126.

Lichtenthaler, U. (2009). Absorptive capacity, environmental turbulence, and the complementarity of organizational learning processes. *Academy of Management Journal*, *52*(4), 822-846.

Mariano, S., & Walter, C. (2015). The construct of absorptive capacity in knowledge management and intellectual capital research: content and text analyses. *Journal of Knowledge Management*, *19*(2), 372-400.

Nitzl, C., Roldán, J. L., & Cepeda Carrión, G. (2016). Mediation Analysis in Partial Least Squares Path Modeling: Helping Researchers Discuss More Sophisticated Models. Industrial Management & Data Systems.

Noblet, J. P., Simon, E., & Parent, R. (2011). Absorptive capacity: a proposed operationalization. *Knowledge Management Research & Practice*, *9*(4), 367-377.

Nonaka, I., & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. Oxford university press.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *The Journal of Economic Perspectives, 9*(4), 97-118.

Rigdon, E. E. (2016). Choosing PLS path modeling as analytical method in European management research: A realist perspective. *European Management Journal, 34*(6), 598-605.

Setia, P., & Patel, P. C. (2013). How information systems help create OM capabilities: Consequents and antecedents of operational absorptive capacity. *Journal of Operations Management, 31*(6), 409-431.

Tsai, W. (2001). Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal, 44*(5), 996-1004.

Tseng, M. L., Huang, F. H., & Chiu, A. S. (2012). Performance drivers of green innovation under incomplete information. *Procedia-Social and Behavioral Sciences, 40*, 234-250.

Van Den Bosch, F. A., Van Wijk, R., & Volberda, H. W. (2003). Absorptive capacity: antecedents, models and outcomes.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185-203.

CHAPTER 7

Overall conclusions, Implications, Limitations and Future lines of research

CHAPTER 7: OVERALL CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND FUTURE LINES OF RESEARCH

7.1. Introduction

The general objective of this dissertation is to investigate and obtain deeper knowledge about the antecedents that explain the development of firms' green innovation outcomes within a sample of companies shaping the automotive components manufacturing sector in Spain (ACMS), as well as the results that are derived from its application. The green innovation topic is of increasing interest both for researchers and managers who want to implement this type of innovation inside their companies. This chapter presents the conclusions of this dissertation. Hence, it bgins with a general discussion covering the principal results obtained from the literature review and empirical analysis of the data and it concludes with some conclusions, implications for theory and practice, limitations and future lines of research.

The main purpose of this dissertation, which is explicitly set out in the introductory chapter, deals with the achievement of a deeper understanding of the roles played by dynamic capabilities, a firm's knowledge base, absorptive capacity and relationship learning mechanisms in the development of green innovation performance.

These antecednts or drivers are hypothesized to lead to a development and improvement of firms' green innovation performance in order to effectively compete within the currently uncertain and constantly changing environment.

This study broadly approaches this aim by trying to provide answers to the following research questions, which are divided into four blocks:

Question 1: What are the conceptual roots of the green innovation variable?

Question 2: To what extent do the existing internal capabilities of firms and their interaction with external knowledge sources —relationship learning enhancement —affect the level of green innovation performance?

Question 3: How does the presence of relationship learning actually affect the link between a firm's knowledge base and green innovation performance?

Question 4: How does a firm's potential absorptive capacity influence realized absorptive capacity? How does a firm's potential absorptive capacity influence the creation of green innovation through processes and products? How does a firm's realized absorptive capacity influence the creation of green innovation through processes and products?

Along the introduction and development of the four main chapters, together with the theoretical background gathered in Chapter 2, we have proposed to respond to the key research questions and to empirically test the relations postulated. The first research question is dealt with in Chapter 3. The second question is considered in Chapter 4. Chapter 5 assesses the third research question. Lastly, Chapter 6 evaluates the fourth research question.

Below, we firstly present the general and particular conclusions of the chapters that make up this thesis. Subsequently, we present the theoretical and practical implications for managers. To finish the chapter, we include a section containing some limitations and future lines of research.

7.2. Overall conclusions

With the emergence of more rigid and strict environmental measures, companies have had to work quickly to adapt their products and processes to the market's environmental needs. In this situation, companies view the implementation of green innovation as an opportunity that should be included in their action strategy plans to reduce the environmental effects of their production activities (Weng and Lin, 2011; Zhu et al., 2012; Bocken et al., 2014). In this way, companies can reduce production costs at the same time as they increase their efficiency by applying environmental practices. Moreover, green practices contribute to enhance corporate reputation and image (Chen, 2008).

In this thesis, we argue that companies acting in a changing environment need to be especially aware of the need to generate superior green innovation performance. To create this type of innovation, firms should identify, adapt to and combine external and internal resources and capabilities.

In this dissertation, based on a conceptual framework founded on the knowledge-based view (KBV), the resource-based view (RBV), the dynamic capabilities view (DCV) and the relationship view (RV), we have proposed three research models in order to test the link between the development of resources and capabilities with the generation of green innovation performance within the a sample of firms belonging to the Spanish automotive components manufacturing sector (ACMS).

The first empirical research was presented in Chapter 4. This connects dynamic capabilities, relationship learning and green innovation performance. In this chapter, we hypothesize and empirically test the research question in the ACMS.

A second research model was shown in Chapter 5 that links the knowledge base and green innovation performance. In addition, in this research model we hypothesize and test the mediating effects of the knowledge base in this relation. In this chapter, we hypothesize and empirically test the research question in the ACMS.

The third research model, included in Chapter 6, links the interrelationship between the two dimensions of absorptive capacity –PACAP and RACAP- with green product innovation performance and green process innovation performance. This chapter goes a step beyond analyzing the green innovation performance attained through products and processes separately.

The results of this thesis aim to contribute to the increase of both theoretical and empirical knowledge at the academic level and at a practical level for companies and those in charge of operations. The results obtained also allow us to conclude that there are three overall conclusions.

The first conclusion of this thesis is that the companies' base of resources and capabilities is essential for the development of green innovations, since it allows them to obtain a competitive advantage in dynamic and turbulent environments.

Organizations are different from each other. For this reason, companies have to work hard to acquire and develop the combination of resources and capabilities that allow them to adapt to the environmental needs identified in the market and society in general, and acquire a favorable position in relation to their competitors.

In this vein, the most valuable resource within companies these days is its knowledge base. A firm's knowledge base establishes the possibility and ability to understand and employ novel knowledge for problem solving, decision making or innovations development (Ahuja and Katila, 2001). For this reason, companies should have a deep and broad knowledge base, since it enables its preparation for catalyzing new ideas that might lead to launching innovative products and services successfully. However, it is necessary for companies to develop and keep absorptive capacity to improve their outcomes and spread competitive advantages, given that this absorptive capacity can strengthen, reorient or supplement the previous organizational knowledge base, as well as interpret and exploit the new knowledge acquired.

In addition, dynamic capabilities allow firms to develop particularly unique, reliable and satisfactory combinations of internal and external resources that may lead to creating value for the customers and other stakeholders, whose needs are continually evolving. Therefore, green innovation performance requires firms to implement changes on the basis of dynamic capabilities development and effective knowledge absorption and management processes.

The second conclusion of this study is the importance of the companies' creation of relationship learning ties with their stakeholders in order to learn about new environmental requirements and in this way adapt their resources and capabilities to obtain green innovation performance. Relationship learning is a joint activity between the firm and one or more parts –supplier, customer, partner, competitors, etc.–, whose objective is to share information and strenghthen the knowledge base (Leal-Rodríguez et al., 2014). For example, it is important that the companies build and maintain relationship learning mechanisms with their suppliers to negotiate the type of raw material that they need or the packaging design. Consequently, companies should share, combine and integrate information about environmental topics to improve their yields.

The last conclusion of the present thesis is that there are not significant differences between green product and process innovation. Green product innovation deals with the introduction of new products or services characterized by waste recycling, energy-saving or reducing the use of polluting resources, whereas green process innovation is connected with the development of production which satisfies the requirements of environmental protection. These two types of innovation are interrelated as developing a green product innovation adapts the processes that operators take into account of the environmental requirements which should be followed. As a result, green process innovations are worked out with the idea of creating eco-friendly products that respect and care for the environment, or modify existing products in a firm's portfolio with the intention of adapting them to the new needs of the market. The empirical results extracted reveal that potential and realized absorptive capacity are positively linked to both green product and process innovation performance.

Next, we present the particular conclusions drawn from the four chapters that comprise the core of this thesis.

7.3. Particular conclusions extracted from chapters

The core of this thesis comprises four main chapters (Chapters 3 to 6). The main target of the first chapter deals with knowing how, when and where the term green innovation arose. To do so, the study carries out a bibliometric analysis of the green innovation topic within the field of business economics. This chapter provides a general overview of the previous studies on green innovation to define the areas within which researchers are learning the topic, the most relevant journals, the most influential authors, the productivity by countries and empirical studies in this field.

This study reaches the following conclusions: (i) the journals with the most number of articles are Technological Forecasting and Social Change and Business Strategy and the Environment; (ii) the countries with more publications are the USA, China and the UK; (iii) the most prolific authors on the topic are Yu-Shan Chen, Ching-Hsun Chang and Joseph Sarkis ; (iv) the antecedent variables acting as key drivers of GI in these studies include: environmental regulations, environmental normative levels, environmental leadership, environmental culture, stakeholders' environmental requests, knowledge sharing, relationship learning and information technology; (v) the research trends and popular issues are innovation, sustainability, sustainable development, green innovation, and environment, among others; (vi) the key outcomes of GI are environmental performance, financial performance, competitive advantages, green image and customer capital. In addition, the key scientific gaps on this topic include regulatory stakeholders, community stakeholders, government support and organizational support.

For that reason, this study is a guide for academics who enter the field in order to build a strong literature review. It is thus very useful for authors because it provides an overview of ideas and knowledge for future research.

The objective of Chapter 4 is to measure how the existing internal capabilities of firms and their interaction with external sources of knowledge –relationship learning– affect the firms' level of green innovation performance. This study proves the mediating role that relationship learning plays in the dynamic capabilities-green innovation performance link. In fact, empirical results show that the direct effect and indirect effect of dynamic capabilities and relationship learning on green innovation performance are positive and significant. Hence, this study concludes that firms need to develop dynamic capabilities that enable them to integrate and adapt internal and external resources obtained in the process of relationship learning to better respond to environmental challenges (Chen, 2008; Gavronski et al., 2011).

Chapter 5 develops a model that explores the link between firms' knowledge base, relationship learning and green innovation performance to know how relationship learning affects the knowledge base-green innovation performance link. The results of this empirical analysis reveal that both the total and indirect effects of the firms' knowledge base on green innovation performance are positive and significant. Moreover, relationship learning positively affects the relationship between the organizational knowledge base and green innovation performance. In conclusion, green innovation performance is a consequence of the knowledge base. Yet companies need to develop structures in which members exchange and learn about external experiences and knowledge with their stakeholders (Cheung et al., 2011) to foster green innovations.

Finally, based on the prior related literature (Cohen and Levinthal, 1990; Zahra and George, 2002; Leal-Rodríguez et al., 2014), Chapter 6 presents a research model that links the firm's knowledge absorptive capacity in its two dimensions –potential and realized absorptive capacity– with green product and process innovation. In this chapter, we are going a step beyond analyzing the green innovation of products and processes separately. The results of the model reveal that potential and realized absorptive capacity are positively connected to both green product innovation performance and green process innovation performance. Furthermore, realized absorptive capacity shows a mediator role between potential absorptive capacity and green process and product innovation performance. The chapter proposes firms to not exploit external knowledge without previously having acquired and assimilated it, which suggests that PACAP precedes RACAP (Zahra and George, 2002). When it has a higher probability of interpreting new knowledge (PACAP), a firm will be more proactive in the explotation of new opportunities that emerge in the society's environment (RACAP). Thus, PACAP can also deliver a reason for aggregating RACAP.

Having presented the conclusions reached in the present thesis, we comment on the possible implications for theory and practice that might be extracted from this work.

7.4. Theoretical and practical implications

The Spanish automotive components manufacturing sector is a great example of an innovation-oriented, knowledge-intensive and sustainable industry. These firms are required to be constantly aware of the changes, requirements and needs demanded by their main customers, the automobile manufacturers. The attainment and interchange of pertinent information as well as the development of specific capabilities within the firm has become a fundamental step in the path of creating green innovation and enhancing performance.

This thesis offers some remarkable contributions to the literature in the fields of knowledge and innovation management. First, we have carried out a thorough theoretical review of the previous works regarding interesting constructs and topics. Green innovation is a subject of increasing interest for companies because all companies wish to find ways to increase the creation and appropriation of value, at the same time as protecting the environment. The knowledge base is considered to be a strategic resource since it can be used for decision making, innovations and difficulties solving (Ahuja and Katila, 2001). In addition, the acquisition and interchange of knowledge and its further absorption within the firm has become an essential stage in the path of enhancing performance. Dynamic capabilities are also considered to be strategic tools to reconfigure organizational resources and routines in the form which is imagined and considered to be appropriate for the main decisions to be made (Zhara et al., 2006). When firms share knowledge and information with suppliers and customers, they enrich their knowledge base, capabilities and competitiveness through relationship-level learning (Leal-Millan et al., 2017).

Second, our study has included a thorough and intense theoretical review as well as an empirical study of the manufacturing industry of equipments and components for the automotive sector in Spain. This method helps to overcome the lack of empirical works assessing the firms' knowledge base, absorptive capacity, dynamic capabilities and relationship learning mechanisms as drivers of green innovation performance, where the measurements of variables tend to be sporadic and are frequently established on mere proxies.

The results of this study could enhance the current environmental management of companies and direct them toward a form of management that creates a higher performance, which ultimately shapes the main target of all companies today.

Our study is based on the premise that companies may possess the knowledge and skills needed to create green innovation performance. If each variable contributes individually to the creation of this type of innovation, would it be possible for the combination of these variables to increase its positive effect? The main idea underlying this study is that the interaction of the organizational knowledge base, absorptive capacity, relationship learning and dynamic capabilities encourages the creation of new green innovation in current dynamic environments. Therefore, managers must realize that such combination of resources and capabilities is, since the above mentiones variables are important individually and are related to each other to create and sustain green innovation performance.

The main implications for senior management are as follows. First, this thesis delivers a theoretical and empirical basis for the subsequent analysis of the innovative activity of the firms within the manufacturing industry of automotive components in Spain. These companies are the suppliers of the main companies of the automobile sector -Ford, Peugeot and Citroën, etc.- characterized by air emissions that cause climate change, pollution, greenhouse gas emissions and human disorders. For this reason, managers should implement strategies that develop innovations which are sustainable and allow them to be more efficient and environmentally friendly.

Second, we intend to guide managers in order for them to know what to do to implement sustainable innovations that may have an impact on producing major benefits. The firm may have the necessary aptitudes to implement this type of innovation but may be not aware of what should do be done with it. Therefore, managers must devote more time and resources to strengthen their knowledge-related and dynamic capabilities as critical tools to foster green innovation performance in manufacturing industries. In addition, our findings should also encourage decision-makers to nurture and promote relationship learning mechanisms with their main stakeholders with the aim of obtaining the pertinent insights and knowledge that might be useful in the development of green innovations. For this purpose, involving suppliers, customers and other interested actors within the whole productive and delivery process might constitute an initial but necessary step while attempting to develop a greener transformation and provision of goods and services.

To conclude, this thesis offers both academics and professionals an open door to the generation and/or maintenance of green innovations, or at least the initial adaptation of the firm’s current innovative activity to the environmental requirements and challenges, in order to attain sustainable competitive advantages.

7.5. Limitations

This thesis is not free from limitations. All empirical research has limitations that must be taken into account when judging and generalizing its results. One of the main limitations of which we are aware is that our research was carried out at a particular moment. The data compilation took place from September to November 2015. Although a longitudinal research would have increased the wealth of the study, we have opted for a transversal investigation due to economic and time limitations.

Secondly, the current study takes place in a particular geographical context (Spain), and specific economic sector (the automotive components manufacturing sector). For these reasons, we must be careful about generalizing these results and conclusions to other sectors, profiles of firms or different contexts.

The third limitation concerns the methodological approach. The application of structural equation modeling involves causal relationships being linear. If this was not really so, we obviously would be simplifying it.

Finally, the number of observations referred to in the model also raises an important limitation. The sample used is 112 companies belonging to the Spanish automotive components manufacturing sector. However, the list of Sernauto recognized that there are up to 960 companies shaping this particular industry.

7.6. Future lines of research

We believe that this research provides a starting point for future investigations related to the creation and enhancement of green innovation performance in firms. In this thesis, we have presented three models that can be used as a basis for the development of future research projects. The possible future investigations are related with the limitations previously indicated.

In the first place, the expansion of our research over time. As we have mentioned previously, it would be interesting to carry out a longitudinal study to analyze and compare the results over time. It would be of interest to conduct a study in different stages of the innovation process. Second, we suggest the development of research in various other sectors of economic activity, in order for the generalizations to be comprehensive and consistent. We believe that the variables proposed are easily adaptable to other contexts.

Finally, it would be desirable to carry out extensions of the model to other capabilities that may influence the generation of firms' green innovation performance (e.g., organizational unlearning or information technologies capacity). For this purpose, perhaps a case study might be useful, as it may provide us qualitative data and insights that could be helpful to sustain and validate our research hypotheses.

7.7. References

Ahuja, G., & Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strategic Management Journal*, *22*(3), 197-220.

Bocken, N. M. P., Farracho, M., Bosworth, R., & Kemp, R. (2014). The front-end of eco-innovation for eco-innovative small and medium sized companies. *Journal of Engineering and Technology Management*, *31*, 43-57.

Chen, Y. S. (2008). The driver of green innovation and green image–green core competence. *Journal of Business Ethics*, *81*(3), 531-543.

Cheung, M. S., Myers, M. B., & Mentzer, J. T. (2011). The value of relational learning in global buyer-supplier exchanges: a dyadic perspective and test of the pie-sharing premise. *Strategic Management Journal*, *32*(10), 1061-1082.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152.

Gavronski, I., Klassen, R. D., Vachon, S., & do Nascimento, L. F. M. (2011). A resource-based view of green supply management. *Transportation Research Part E: Logistics and Transportation Review*, *47*(6), 872-885.

Leal-Millán, A., Albort-Morant, G., Leal-Rodríguez, A., & Ariza-Montes, A. (2017). Relationship Learning Strategy as a Mechanism of Network and the Effectiveness of Green Innovation. In Cooperative and Networking Strategies in Small Business (pp. 81-95). Springer International Publishing.

Leal-Rodríguez, A. L., Roldán, J. L., Ariza-Montes, J. A., & Leal-Millán, A. (2014). From potential absorptive capacity to innovation outcomes in project teams: The conditional mediating role of the realized absorptive capacity in a relational learning context. *International Journal of Project Management*, *32*(6), 894-907.

Weng, M. H., & Lin, C. Y. (2011). Determinants of green innovation adoption for small and medium-size enterprises (SMES). *African Journal of Business Management*, *5*(22), 9154.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, *27*(2), 185-203.

Zahra, S. A., Sapienza, H. J., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: a review, model and research agenda. *Journal of Management Studies*, *43*(4), 917-955.

Zhu, Q., Sarkis, J., & Lai, K. H. (2012). Examining the effects of green supply chain management practices and their mediations on performance improvements. *International Journal of Production Research*, *50*(5), 1377-1394.

APPENDIX A. Questionnaire presentation letter

Estimado Sr./Sra.:

Nos dirigimos a usted con el fin de solicitar su colaboración en el desarrollo de un estudio doctoral sin ánimo de lucro que estamos llevando a cabo sobre la sostenibilidad en la industria española y sus principales variables predictoras. Para ello, emplearemos una muestra de empresas pertenecientes a la industria manufacturera de componentes de automoción en España que hemos obtenido de un listado facilitado por Sernauto.

Dado el reducido tamaño de la muestra seleccionada, su colaboración nos resulta verdaderamente precisa para llevar a cabo nuestra investigación. Por este motivo le estaríamos enormemente agradecidos si le fuera posible completar el cuestionario que le adjuntamos y remitírnoslo a la siguiente dirección de correo electrónico: **galbort@us.es**. Le garantizamos que el trato de la información que nos facilite será totalmente confidencial. Como comprobará, a fin de garantizar el absoluto anonimato, no se requiere ninguna información que identifique su identidad personal ni la de su entidad. El tratamiento estadístico de los datos será siempre a nivel agregado, en ningún caso se procederá a estudios individualizados de su firma.

Si usted lo desea, a cambio de su colaboración estaremos encantados de remitirle los resultados de la investigación. Muchas gracias de antemano por su colaboración.

Atentamente,

Gema Albort Morant,
UNIVERSIDAD DE SEVILLA

APPENDIX B. Questionnaire

INSTRUCTIONS TO COMPLETE THE QUESTIONNAIRE

• Please, answer all the questions. There are no correct answers, only we want to hear your opinion on the issues raised. If any of the questions is not entirely sure of the answer, no matter, we are interested in your estimate.
• Most of the questions are to respond between 1 (there is no agreement with the statement) to 7 (it is fully agreed with the statement). The rest of values graduate these two extremes. Mark with a cross the most appropriate value in each case.
• If you have any questions on any aspect, please don't hesitate to contact us: Prof. Dr. Antonio G. Leal Millán (aleal@us.es) or Gema Albort Morant (galborts.es).

GREEN INNOVATION PERFORMANCE (GIP)

In my company…	**High Disagreement**						**High Agreement**
GIP1 My company chooses the materials of the product that produce the least amount of pollution for conducting the product development or design	1	2	3	4	5	6	7
GIP2 My company chooses the materials of their products that consume the least amount of energy and resources for conducting the product development or design	1	2	3	4	5	6	7
GIP3 My company uses the fewest amount of materials to comprise their products for conducting the product development or design	1	2	3	4	5	6	7
GIP4 My company would circumspectly evaluate whether their products are easy to recycle, reuse, and decompose for conducting the product development or design	1	2	3	4	5	6	7
GIP5 My manufacturing process of the company effectively reduces the emission of hazardous substances or wastes	1	2	3	4	5	6	7
GIP6 The manufacturing process of my company effectively recycles wastes and emission that can be treated and re-used	1	2	3	4	5	6	7
GIP7 The manufacturing process of my company effectively reduces the consumption of water, electricity, coal, or oil	1	2	3	4	5	6	7
GIP8 The manufacturing process of my company effectively reduces the use of raw materials	1	2	3	4	5	6	7

DYNAMIC CAPABILITIES (DC)

On a 1 to 7 scale (1 = strongly disagree, 7 = strongly agree), in my organization	**Strongly Disagree**						**Strongly Agree**
DC SC1 We frequently scan the environment to identify new business opportunities.	1	2	3	4	5	6	7
DC SC2 We periodically review the likely effect of changes in our business environment on customers.	1	2	3	4	5	6	7
DC SC3 We often review our product development efforts to ensure they are in line with what the customers want.	1	2	3	4	5	6	7
DC SC4 We devote a lot of time implementing ideas for new products/process and improving our existing products/process.	1	2	3	4	5	6	7
DC LC1 We have effective routines to identify, value, and import new information and knowledge	1	2	3	4	5	6	7
DC LC2 We have adequate routines to assimilate new information and knowledge.	1	2	3	4	5	6	7

DC LC3 We are effective in transforming existing information into new knowledge.	1 2 3 4 5 6 7
DC LC4 We are effective in utilizing knowledge into new products.	1 2 3 4 5 6 7
DC LC5 We are effective in developing new knowledge that has the potential to influence product development.	1 2 3 4 5 6 7
DC IC1 We are forthcoming in contributing our individual input to the organization.	1 2 3 4 5 6 7
DC IC2 We have a global understanding of each other's tasks and responsibilities.	1 2 3 4 5 6 7
DC IC3 We are fully aware who in the organization has specialized skills and knowledge relevant to our work.	1 2 3 4 5 6 7
DC IC4 We carefully interrelate our actions to each other to meet changing conditions.	1 2 3 4 5 6 7
DC IC5 Organization members manage to successfully interconnect their activities.	1 2 3 4 5 6 7
DC CC1 We ensure that the output of our work is synchronized with the work of others.	1 2 3 4 5 6 7
DC CC2 We ensure an appropriate allocation of resources (e.g., information, time, reports) within our organization.	1 2 3 4 5 6 7
DC CC3 Organization members are assigned to tasks commensurate with their task-relevant knowledge and skills.	1 2 3 4 5 6 7
DC CC4 We ensure that there is compatibility between organization members expertise and work processes.	1 2 3 4 5 6 7
DC CC5 Overall, our organization is well coordinated.	1 2 3 4 5 6 7
DC RC1: We can successfully reconfigure our resources to come up with new productive assets.	1 2 3 4 5 6 7
DC RC2 We often engage in resource recombination to better match our product-market areas and our assets.	1 2 3 4 5 6 7

KNOWLEDGE BASE (KB)

In my company…	**High Disagreement** — **High Agreement**
KB1 We possess market information from a diversified customer portfolio	1 2 3 4 5 6 7
KB2 We have accumulated knowledge of multiple market segments	1 2 3 4 5 6 7
KB3 Our R&D expertise consists of knowledge from a variety of background	1 2 3 4 5 6 7
KB4 We are highly familiar with this industry	1 2 3 4 5 6 7
KB5 We have acquired a great deal of experience about this industry	1 2 3 4 5 6 7
KB6 The knowledge of our firm in this industry is thorough	1 2 3 4 5 6 7
KB7 We have in-depth knowledge about the technologies in this industry	1 2 3 4 5 6 7

ABSORPTIVE CAPACITY (ACAP)

POTENTIAL ABSORPTIVE CAPACITY (PACAP) ***In my Company...***	**Totally Disagree** — **Totally Agree**
PACAP1 We have frequent interactions with top management to acquire new knowledge	1 2 3 4 5 6 7
PACAP2 Employees regularly visit other units or departments	1 2 3 4 5 6 7
PACAP3 We collect information through informal means (e.g., lunches with colleagues, friends, chats with partners)	1 2 3 4 5 6 7
PACAP4 Members do not visit other units or areas *	1 2 3 4 5 6 7
PACAP5 We periodically organize special meetings with clients, suppliers or third parties to acquire new knowledge	1 2 3 4 5 6 7
PACAP6 Members meet regularly with external professionals such as advisers, managers or consultants	1 2 3 4 5 6 7
PACAP7 We are slow to recognize shifts in our market (e.g., competitors, laws, demographic changes, etc.) *	1 2 3 4 5 6 7
PACAP8 New opportunities to serve our clients are quickly understood	1 2 3 4 5 6 7
PACAP9 We quickly analyze and interpret changing client demands	1 2 3 4 5 6 7
REALISED ABSORPTIVE CAPACITY (RACAP) ***In my Company...***	**Totally Disagree** — **Totally Agree**
RACAP1 We regularly consider the consequences of changing market demands in terms of new ways to provide products/services	1 2 3 4 5 6 7
RACAP2 Employees record and store newly acquired knowledge for future reference	1 2 3 4 5 6 7
RACAP3 We quickly recognize the usefulness of new external knowledge for existing knowledge	1 2 3 4 5 6 7

RACAP4 Employees rarely share practical experiences *	1	2	3	4	5	6	7
RACAP5 We laboriously grasp the opportunities for our unit from new external knowledge *	1	2	3	4	5	6	7
RACAP6 We periodically meet to discuss the consequences of market trends and new services development	1	2	3	4	5	6	7
RACAP7 It is clearly known how activities within our company and unit should be performed	1	2	3	4	5	6	7
RACAP8 Clients' complaints fall on deaf ears in our unit *	1	2	3	4	5	6	7
RACAP9 We have a clear division of roles and responsibilities	1	2	3	4	5	6	7
RACAP10 We constantly consider how to better exploit knowledge	1	2	3	4	5	6	7
RACAP11 We have difficulties implementing new products/services *	1	2	3	4	5	6	7
RACAP12 Employees have a common language regarding our products/services	1	2	3	4	5	6	7

RELATIONSHIP LEARNING (RL)

In my organization…	**High Disagreement**						**High Agreement**
RLIS1 We exchange information on successful and unsuccessful experiences with products exchanged in the relationship with partners and suppliers	1	2	3	4	5	6	7
RLIS2 We exchange information related to changes in end-user needs, preferences, and behavior	1	2	3	4	5	6	7
RLIS3 We exchange information related to changes in market structure, such as mergers, acquisitions, or partnering	1	2	3	4	5	6	7
RLIS4 We exchange information related to changes in the Technology of the focal products	1	2	3	4	5	6	7
RLIS5 We exchange information as soon as any unexpected problems arise	1	2	3	4	5	6	7
RLIS6 We exchange information related to changes in the organizations' strategies and policies	1	2	3	4	5	6	7
RLIS7 We exchange information that is sensitive, such as financial performance and know-how	1	2	3	4	5	6	7
RLJS8 It is common to establish joint teams to solve operational problems in the relationships with partners, suppliers and customers	1	2	3	4	5	6	7
RLJS9 It is common to establish joint teams to analyze and discuss strategic issues in the relationship with partners, suppliers and customers	1	2	3	4	5	6	7
RLJS10 The atmosphere in the relationship with partners, suppliers and customers stimulates productive discussion that encompasses a variety of opinions	1	2	3	4	5	6	7
RLJS11 We have a lot of face-to-face communication in this relationship	1	2	3	4	5	6	7
RLKI12 We frequently adjust our common understanding of end-user needs and behavior	1	2	3	4	5	6	7
RLKI13 We frequently adjust our common understanding of trends in technology related to our business	1	2	3	4	5	6	7
RLKI14 We frequently evaluate and, if needed, adjust our routines in order-delivery processes	1	2	3	4	5	6	7
RLKI15 We frequently evaluate and, if needed, update the formal contracts in our relationship	1	2	3	4	5	6	7
RLKI16 We frequently meet face-to-face to refresh the personal network in this relationship	1	2	3	4	5	6	7
RLKI17 We frequently evaluate and, if needed, update Information about the relationship stored in our electronic databases	1	2	3	4	5	6	7

THANK YOU VERY MUCH FOR YOUR HELP

APPENDIX C. List of enterprises belonging to the Spanish automotive components manufacturing sector

SERNAUTO Asociación Española de Fabricantes de Equipos y Componentes para Automoción

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
RODISA , S.L.	ELGOIBAR	GUIPUZCOA
3M ESPAÑA, S.A.	RIVAS VACIAMADRID	MADRID
3RG INDUSTRIAL AUTO, S.L.	YELES	TOLEDO
A. RAYMOND TECNIACERO, S.A.	SANT FRUITOS DE BAGES	BARCELONA
AC TRANS FERIAS INTERNACIONALES	BARCELONA	BARCELONA
ACCIONA FACILITY SERVICES, S.A.	BARCELONA	BARCELONA
ACR - ACCES.Y COMP.PARA AUTOM.Y REFRIGERACION,S.L.	ALZIRA	VALENCIA
ACTIA MULLER ESPAÑA	GETAFE	MADRID
ACUSTICA BEYMA, S.A	MONCADA	VALENCIA
AEROMETAL, S.A.	PARETS DEL VALLES	BARCELONA
AEROQUIP IBERICA,	ALCALA DE HENARES	MADRID
AGERAUTO - SIA INDUSTRIA ACCUMULATORI SPA	VALENCIA	VALENCIA
AIMEN-ASOC.INVESTIG.METALUTRGICA NOROESTE	PORRIÑO	PONTEVEDRA
AIMME-ASOC.INVESTIGACION INDUST.METAL-MECANICA. AF	PATERNA	VALENCIA
AIMPLAS - INSTITUTO TECNOLOGICO DEL PLASTICO	PATERNA	VALENCIA
AIR-FREN, S.L.	ZARAGOZA	ZARAGOZA
AIRE COMPRIMIDO INDUSTRIAL IBERIA SL	PINTO	MADRID
AIRTEX PRODUCTS, S.A.	ZARAGOZA	ZARAGOZA
AKZO NOBEL CAR REFINISHIES SL	BARCELONA	BARCELONA
AL-KO ESPAÑA SAU	UTEBO	ZARAGOZA
AL-KO RECORD, S.A.	ABADIANO	VIZCAYA
ALCASTING LEGUTIANO, SLU (CIE ALCASTING)	LEGUTIANO	ALAVA
ALCAYATAS Y TORNILLERIA SA ALTOSA	BARCELONA	BARCELONA
ALCORTA FORGIN GROUP S.A.	ELGOIBAR	GUIPUZCOA
ALFA DECO SAU (CIE ALFA DECO)	ELGETA	GUIPUZCOA
ALFA LAN, S.A.	EIBAR	GUIPUZCOA
ALFOMBRAS AUTOMOCION, S.L.- ALFAUTO	VILLENA	ALICANTE
ALKAR AUTOMOTIVE, S.A.	AMOREBIETA	VIZCAYA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
ALUDEC S.A.	VIGO	PONTEVEDRA
ALUMBRADO TECNICO	ARRE	NAVARRA
ALUMINIO Y ALEACIONES, S.A.	ZARAGOZA	ZARAGOZA
ALURECY SA (CIE AUTOMOTIVE)	OROZKO	VIZCAYA
AMADEO MARTI CARBONELL, S.A.	NULES	CASTELLON
AMES, S.A.	SANT FELIU DE LLOBREGAT	BARCELONA
ANGLI INDUSTRIAS, S.A.	CALDES DE MONTBUI	BARCELONA
ANVIS AUTOMOTIVE SPAIN, S.A.U.	SORIA	SORIA
APPLUS+MATERIALES Y PROCESOS INDUSTRIALES	BELLATERRA	BARCELONA
ARALUCE (GESTAMP)	IGORRE	VIZCAYA
ARCELORMITAL DISTRIBUCION	LUGO DE LLANERA	ASTURIAS
ARCELORMITTAL FCE SPAIN SL	MADRID	MADRID
ARIÑO DUGLASS, S.A.	LA PUEBLA DE ALFINDEN	ZARAGOZA
ARTECA CAUCHO-METAL, S.A.	VILLABONA	GUIPUZCOA
ARTUR VIVES, S.A.	VALLS	TARRAGONA
AS, S.L.	BERIAIN	NAVARRA
ASICRO, S.L.	VALENCIA	VALENCIA
ASIENTOS DE CASTILLA Y LEON,S.A. (FAURECIA)	VALLADOLID	VALLADOLID
ASIENTOS DE GALICIA, S.L (FAURECIA)	VIGO	PONTEVEDRA
ASIENTOS DEL NORTE, S.A. (FAURECIA)	VITORIA	ALAVA
ASISTENCIA TECNICA INDUSTRIAL, S.A.E.-ATISAE	TRES CANTOS	MADRID
ASOCIACION ESPAÑOLA PARA LA CALIDAD - AEC	MADRID	MADRID
ASUVESA MAQUINARIA SL	LEON	LEON
AUNDE, S.A.	SANT CELONI	BARCELONA
AUTO JUNTAS, S.A. UNIPERSONAL (AJUSA)	ALBACETE	ALBACETE
AUTO SPOILER-ENRIQUE AGUILAR, S.A.	VALENCIA	VALENCIA
AUTOFLEX KNOTT IBERICA, S.L	GUARNIZO	CANTABRIA
AUTOLIV KLE, S.A.U.	GRANOLLERS	BARCELONA
AUTOLIV-BKI, S.A.	LA POBLA DE VALLBONA	VALENCIA
AUTOMOCION ORYX PARTS, S.L.	LA MUELA	ZARAGOZA
AUTOMOTIVE LIGHTING REAR LAMPS ESPAÑA,MANETI MAREL	LLINARS DEL VALLES	BARCELONA
AUTONEUM	TARRASA	BARCELONA
AUTOSIL ESPAÑA, S.A.	COSLADA	MADRID
AUXILIAR DE LA INDUSTRIA MECANICA, S.A. AUXIM	ARGANDA DEL REY	MADRID
AZ ESPAÑA, S.A.	COSLADA	MADRID
BARNICES VALENTINE, S.A.	MONTCADA I REIXACH	BARCELONA
BASF COATINGS, S.A.	GUADALAJARA	GUADALAJARA
BASS POLIURETANOS IBERIA SA	RUBI	BARCELONA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
BATZ, S.COOP.	IGORRE	VIZCAYA
BENTELER DISTRIBUCION IBERICA, S. L.	PRAT DE LLOBREGAT, EL	BARCELONA
BENTELER ESPAÑA SA	BURGOS	BURGOS
BENTELER JIT MARTORELL	ABRERA	BARCELONA
BETSAIDE, S.A.L.	ELORRIO	VIZCAYA
BIMAR ACCESORIOS	BENETUSE	VALENCIA
BOLLHOFF, S.A.	ALCOBENDAS	MADRID
BORGERS, S.A.	ALCALA DE HENARES	MADRID
BORGWARNER EMITIONS SYSTEMS SPAIN SL	VIGO	PONTEVEDRA
BOSAL ESPAÑA,S.A.	SAGUNTO	VALENCIA
BOSAL INDUSTRIAL ZARAGOZA, S.A.	PEDROLA	ZARAGOZA
BRALO, S.A.	PINTO	MADRID
BRAU, S.A.	SOSES	LERIDA
BRAVO ENTERPRISES, S.L.	AMPUERO	CANTABRIA
BRENNTAG QUIMICAS, S.A.	DOS HERMANAS	SEVILLA
BRIDGESTONE HISPANIA, S.A.	URBI-BASAURI	VIZCAYA
BROSE, S.A.	SANTA MARGARIDA I ELS MONJOS	BARCELONA
BRUGAROLAS, S.A.	RUBI	BARCELONA
BRUSS JUNTAS TECNICAS S.L., S. EN COMANDITA	DURANGO	VIZCAYA
BUGOBROT, S.L.	GETAFE	MADRID
C 2 M, S.A.	EL PAPIOL	BARCELONA
CABLEADOS Y APARATOS DE TABLERO, S.L. - CAYATA	GETAFE	MADRID
CAD TECH IBERICA, S.A.	GETAFE	MADRID
CALIBRADOS DE PRECISION S.A.	LA LLAGOSTA	BARCELONA
CAMPOS 1925, S.A.	POLINYA	BARCELONA
CAPO FASTO SL	BARCELONA	BARCELONA
CARCOUSTICS ESPAÑA, S.A.	ALCASSER	VALENCIA
CARROCERA CASTROSUA, S.A.	SANTIAGO DE COMPOSTELA	LA CORUÑA
CARROCERIAS AYATS, S.A.	ARBUCIAS	GERONA
CARROCERIAS DAFER, S.A.	PADRONES-PONTEAREAS	PONTEVEDRA
CASALS MATERIAL INDUSTRIAL, S.L.	BARCELONA	BARCELONA
CASCOS MAQUINARIA S.A.	VITORIA	ALAVA
CASPLE, S.A.	BURGOS	BURGOS
CASTING ROS, S.A.	UTRILLAS	TERUEL
CAT ESPAÑA LOGISTICA CARGO, S.L. UNIPERSONAL	MADRID	MADRID
CATELSA-CACERES, S.A.	CÁCERES	CÁCERES
CAUCHO METAL PRODUCTOS II, S.L.	LOGROÑO	LA RIOJA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
CELULOSA FABRIL, S.A. -CEFA-	ZARAGOZA	ZARAGOZA
CENTRO TECNOLOGICO BOROA (CIE)	AMOREBIETA	VIZCAYA
CENTRO ZARAGOZA-INSTITUTO REPARACION VEHICULOS	PEDROLA	ZARAGOZA
CEPSA LUBRICANTES, S.A.	MADRID	MADRID
CGR EUROPA, S.L.	MATARO	BARCELONA
CHEMETALL, SDAD. ANMA.	CANOVELLES	BARCELONA
CIDAUT-CENTRO DE INVEST.Y DES. EN TRANSP. Y ENERG.	BOECILLO	VALLADOLID
CIE AUTOMOTIVE S.A.-OFICINA (OF. ADMINISTRATIVA)	ABADIÑO	VIZCAYA
CIE AUTOMOTIVE, S.A.	AZCOITIA	GUIPUZCOA
CIE AUTOMOTIVE- SA	BILBAO	VIZCAYA
CIE GALFOR S.A.	ORENSE	ORENSE
CIE LEGAZPI, SA (CIE LEGAZPI)	LEGAZPIA	GUIPUZCOA
CIE MECAUTO SAU (CIE MECAUTO)	VITORIA	ALAVA
CIE UDALBIDE S.A.U	IZURZA	VIZCAYA
CIGÜEÑALES SANZ, S.L.	ZARAGOZA	ZARAGOZA
CIKAUTXO,S.COOP.	BERRIATUA	VIZCAYA
CITEAN - FUNDACION CETENA	NOAIN	NAVARRA
CODIPAUTO, S.L.	EIBAR	GUIPUZCOA
COJALI S.L.	CAMPO DE CRIPTANA	CIUDAD REAL
COMERCIAL DE LA FORJA, S.A. - COMFORSA - PLANTA 2	BARCELONA	BARCELONA
COMERCIAL DE LA FORJA, S.A. - COMFORSA - PLANTA 3	BARCELONA	BARCELONA
COMERCIAL DE LA FORJA, S.A.- COMFORSA	BARCELONA	BARCELONA
COMERCIAL DEL MOTOR, S.A.	MADRID	MADRID
COMERCIAL JOPE, S.AL	EGÜES	NAVARRA
COMPAÑIA GENERAL DE LUBRICANTES, S.A.-COGELSA	SAN ANDRES DE LA BARCA	BARCELONA
COMPONENTES DE AUTOMOCION RECYTEC, SLU (CIE RECYTE	LEGUTIANO	ALAVA
COMPONENTES DE DIRECCIÓN RECYLAN SL (CIE RECYLAN)	ORKOYEN	NAVARRA
COMPONENTES DE VEHICULOS DE GALICIA, S.A.	PORRIÑO	PONTEVEDRA
COMPONENTES METALICOS DEL MEDITERRANEO, S.A.U.	SAN CUGAT DE SESGARRIGUES	BARCELONA
COMPONENTES Y RECAMBIOS SL	ORICAIN	NAVARRA
CONDENSIA QUIMICA, S.A.	BARCELONA	BARCELONA
CONSTRUCCIONES MECANICAS ARAGONESAS, S.A.	ZARAGOZA	ZARAGOZA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
CONTINENTAL AUTOMOTIVE SPAIN, S.A.	RUBI	BARCELONA
COOPER-STANDARD AUTOMOTIVE ESPAÑA, S.L.	GETAFE	MADRID
COPO FEHRER BARCELONA, S.L.	VILANOVA DEL CAMI	BARCELONA
COPO IBERICA, S.A.	MOS	PONTEVEDRA
COPO ZARAGOZA SAU	FUENTES DE EBRO	ZARAGOZA
CORPORACION GESTAMP	MADRID	MADRID
CORPORACION UPWARDS 98, S.A.	LA MUELA	ZARAGOZA
COVER APLICACIONES TECNICAS	BARCELONA	BARCELONA
CRAMSA INDUSTRIAL, S.L.	HUMANES DE MADRID	MADRID
CROUZET IBERICA, S.A.	BADALONA	BARCELONA
CRUZBER, S.A.	RUTE	CORDOBA
CSA AUTOMOTIV MADRID SL	TORREJON DE ARDOZ	MADRID
CTAG-CENTRO TECNOLOGICO DE AUTOMOCION DE GALICIA	PORRIÑO, O	PONTEVEDRA
CUYMAR SUSPENSION PARTS S.L.	LA MUELA	ZARAGOZA
DALPHI METAL ESPAÑA, S.A.	VIGO	PONTEVEDRA
DANA AUTOMOCION, S.A./ SERVA	ZARAGOZA	ZARAGOZA
DAYCO AUTOMOTIVE-SUCURSAL EN ESPAÑA	SANT FRUITOS	BARCELONA
DAYCO EUROPE AFTERMARKET, S.L.	BARCELONA	BARCELONA
DECOLETAJE Y TORNILLERIA -DYTSA-	BANYOLES	GERONA
DELPHI DIESEL SYSTEMS, S.L. (SOCIEDAD UNIPERSONAL)	SAN CUGAT DEL VALLES	BARCELONA
DELPHI MECATRONIC	SANT VINCENT DELS HORTS	BARCELONA
DELPHI PACKARD ESPAÑA, S.ALU	PAMPLONA	NAVARRA
DENSO BARCELONA,SA.	SANT FRUITOS DE BAGES	BARCELONA
DEUSTO	ZAMUDIO	VIZCAYA
DEUTZ SPAIN	ZAFRA	BADAJOZ
DICOMOL, S.L.	MONTCADA I REIXACH	BARCELONA
DIRNA BERGSTROM, S.L.U.	ALCALA DE HENARES	MADRID
DISTRIBUIDORA ACUMULADORES IMPORTADOS,SA-DAISA-	GIJON	ASTURIAS
DISYUNTOR REGULADOR ASD, S.A.	GETAFE	MADRID
DOGA, S.A.	ABRERA	BARCELONA
DOISTUA, S.A.	GALDACANO	VIZCAYA
DR. FRANZ SCHNEIDER, S.A.-UNIPERSONAL	PICASSENT	VALENCIA
DROGAS VIGO, S.L. - DROVI	PORRIÑO	PONTEVEDRA
DRYASA AUTOMOCION INDUSTRIAL, S.L.	BURGOS	BURGOS
DUPONT IBERICA SL	BARCELONA	BARCELONA
DYNACAST ESPAÑA, S.A.	SANTA PERPETUA DE MOGODA	BARCELONA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
DYS,S.L.-DIRECCION Y SUSPENSION, S.L.	EGÜES	NAVARRA
DYTRAM, S.A.	VILADECANS	BARCELONA
ECENARRO S.COOP.	VERGARA	GUIPUZCOA
EDSCHA BURGOS S.A. (GESTAMP)	BURGOS	BURGOS
EDSCHA SANTANDER (GESTAMP)	GUARNIZO	CANTABRIA
EFTEC SYSTEMS S.A.	FIGUERUELAS	ZARAGOZA
EGAÑA 2, S.L. (CIE EGAÑA)	ABADIANO	VIZCAYA
EGRO, S.L.	ORTUELLA	VIZCAYA
ELASTIC BERGER, S.A.	TARRASA	BARCELONA
ELAY INDUSTRIAL, S.A.	ANZUOLA	GUIPUZCOA
ELAY, S.L	ANZUOLA	GUIPUZCOA
ELECTRO AUTO, S.A.	COSLADA	MADRID
ELECTRO CRISOL METAL, S.A. (ECRIMESA)	SANTANDER	CANTABRIA
ELECTROMECANICA CORMAR, S.A.	LLINARS DEL VALLES	BARCELONA
ELECTRONICA DABEL, S.A. (ELEDASA)	CORBERA DE LLOBREGAT	BARCELONA
ELRINGKLINGER, S. A.	REUS	TARRAGONA
EMAR MANUFACTURAS METALICAS, S. A.	LOGROÑO	LA RIOJA
EMBEGAS, S. COOP.	VILLATUERTA	NAVARRA
ENGANCHES Y REMOLQUES ARAGON, S.L.	ZARAGOZA	ZARAGOZA
ENGINE POWER COMPONENTS GROUP EUROPE, S.L.-EPCGE	EIBAR	GUIPUZCOA
EQUAL, S.A.	VALDEMORO	MADRID
EQUIPOS DE TRANSMISIÓN S.A	VITORIA	ALAVA
ERMA, S.L.	PORRIÑO	PONTEVEDRA
ERSA-PARTS FILTER, S.L.	SANT PERE DE RIBES	BARCELONA
ESMEBAGES, S.L.U.	SANTPEDOR	BARCELONA
ESPECIALIDADES ELECTRICAS LAUSAN ,S.A.	BILBAO	VIZCAYA
ESPECIALIDADES ELECTRONICAS RIZOPLAST, S.L.	MATARÓ	BARCELONA
ESPECIALITATS ELECTRIQUES ESCUBEDO, S.A.	RIUDELLOTS DE LA CREU	GIRONA
ESPYTES, S.A.	OÑATE	GUIPUZCOA
ESTAMPACIONES FOGA, S.A.	SANT FELIU DE LLOBREGAT	BARCELONA
ESTAMPACIONES GIPUZKOA, S.A.	AIA	GUIPUZCOA
ESTAMPACIONES IRU, S.L.	ABADIANO	VIZCAYA
ESTAMPACIONES MAYO, S.A.	MUTILVA ALTA	NAVARRA
ESTAMPACIONES METALICAS EGUI, S.A.	ERMUA	VIZCAYA
ESTAMPACIONES METALICAS Y TRANSFORMADOS INDUSTRIAL	SANT ANDRES DE LA BARCA	BARCELONA
ESTAMPACIONES MODERNAS, S.L.	ZARAGOZA	ZARAGOZA
ESTAMPACIONES NAVARRA, S.A. -ESNASA-	BERIAIN	NAVARRA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
ESTAMPACIONES RUBI, S. A.	VITORIA	ALAVA
EUROALAGON SERVICIOS, S.L.	ALAGON	ZARAGOZA
EUROCAUCHOS CANA S.L.	ORCOYEN	NAVARRA
EUROFREN SYSTEMS, S.L.U.	MULTIVA	NAVARRA
EUROPEA DE FRICCION, S.A. IBERBRAKES	MADRID	MADRID
EXIDE TECHNOLOGIES, S.L.U.	AZUQUECA DE HENARES	GUADALAJARA
EXTENDA-AGENCIA ANDALUZA DE PROMOCION EXTERIOR S.A	SEVILLA	SEVILLA
FABRICACION ASIENTOS VEHICULOS INDUSTRIALES,S.A.	MARTORELLAS	BARCELONA
FAE-FRANCISCO ALBERO, S.A.	HOSPITALET DE LLOBREGAT,L'	BARCELONA
FAGOR EDERLAN TAFALLA, S. COOP.	TAFALLA	NAVARRA
FAGOR EDERLAN,S.COOP.LTDA.(PLANTA 2-SUSPENSION)	ESCORIAZA	GUIPUZCOA
FAGOR EDERLAN,S.COOP.LTDA.(PLANTA 3-TRANSMISION)	ESCORIAZA	GUIPUZCOA
FAGOR EDERLAN,S.COOP.LTDA.(PLANTA 4-FRENO)	ESCORIAZA	GUIPUZCOA
FAGOR-EDERLAN, S.COOP.LTDA.(PLANTA 1 - MOTOR)	ESCORIAZA	GUIPUZCOA
FAIST INSONITE SA	TARRASA	BARCELONA
FARE, S.A.	SANTA PERPETUA DE MOGODA	BARCELONA
FAURECIA	ORCOYEN	NAVARRA
FAURECIA ASIENTOS AUTOMOVILES ESPAÑA, S.A.	MADRID	MADRID
FAURECIA AUTOMOTIVE ESPAÑA, S.A.	MADRID	MADRID
FAURECIA AUTOMOTIVE ESPAÑA, S.L.	MADRID	MADRID
FAURECIA AUTOMOTIVE ESPAÑA, S.L.	MADRID	MADRID
FAURECIA AUTOMOTIVE ESPAÑA, S.L.	MADRID	MADRID
FAURECIA AUTOMOTIVE EXTERIORS ESPAÑA SAU	SANT ANDRES DE LA BARCA	BARCELONA
FAURECIA INTERIOR SYSTEMS ESPAÑA S.A.	PORRIÑO	PONTEVEDRA
FAURECIA INTERIOR SYSTEMS ESPAÑA, S.A.	QUART DE POBLET	VALENCIA
FAURECIA INTERIOR SYSTEMS SALC ESPAÑA, S.L.	QUART DE POBLET	VALENCIA
FAURECIA INTERIOR SYSTEMS SALC ESPAÑA, S.L.	QUART DE POBLET	VALENCIA
FAURECIA MADRID JIT (VILLAVERDE)	MADRID	MADRID
FAURECIA SISTEMAS DE ESCAPE ESPAÑA, S.A.	VIGO	VIGO
FAURECIA SISTEMAS DE ESCAPE ESPAÑA, S.A.	MADRID	MADRID
FAURECIA SISTEMAS DE ESCAPE ESPAÑA, S.A.	MADRID	MADRID
FEDERAL MOGUL AUTOMOTIVE IBERICA, S.A.	BARCELONA	BARCELONA
FEDERAL SIGNAL VAMA, S.A.U	VILASSAR DE DALT	BARCELONA
FEDERAL-MOGUL FRICTION PRODUCTOS, S.A.	BADALONA	BARCELONA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
FELSAN, PERFECTO Y PEDRO, S.A.	ALBACETE	ALBACETE
FERDINAND BILSTEIN ESPAÑA, S. L.	ZARAGOZA	ZARAGOZA
FERRODISA	PUERTO DE SAGUNTO	VALENCIA
FERSA BEARINGS, S.A.	ZARAGOZA	ZARAGOZA
FERVE, S.A.	EL VENDRELL	TARRAGONA
FIBERPACHS, S.A.	PACS DEL PENEDES	BARCELONA
FICO CABLES, S.A.	BARCELONA	BARCELONA
FICO MIRRORS , S.A.	MOLLET DEL VALLÉS	BARCELONA
FICO TRANSPAR, S.A.	BARCELONA	BARCELONA
FICO TRIAD, S.A.	RUBI	BARCELONA
FIJACIONES INDUSTRIALES, PRELOK	CORNELLA	BARCELONA
FIT AUTOMOCIÓN, S.A	VERGARA	GUIPUZCOA
FLEX 'N' GATE ESPAÑA	LES FRANQUESES DEL VALLES	BARCELONA
FLEXIX, S.A.	ZAMUDIO	VIZCAYA
FONEXION SPAIN, S.A.	BILBAO	VIZCAYA
FORBO ADHESIVES SPAIN, S.L.U.	MOS	PONTEVEDRA
FORGING PRODUCTS TRADING	AMOREBIETA	VIZCAYA
FORJANOR, S.L. (GERDAU ACEROS ESPECIALES EUROPA, S	COLLADO-VILLALBA	MADRID
FPK, LIGHT WEIGHT TECHNOLOGIES SOC COPERAT	ZAMUDIO	VIZCAYA
FRENKIT, S.L.	PUENTE LA REINA	NAVARRA
FRENOS ELECTRICOS UNIDOS, S.A.	ORCOYEN	NAVARRA
FRENOS IRUÑA, S.A.L.	GALAR	NAVARRA
FRENOS SAULEDA, S. A.	SAN CIPRIANO DE VALLALTA	BARCELONA
FRENOS Y DISCOS, S.A. -FRENDISA-	AMER	GERONA
FRENOS ZARAGOZA, S.A.	SOBRADIEL	ZARAGOZA
FREUDENBERG IBERICA, S.A. S. EN C.	PARETS DEL VALLES	BARCELONA
FUCHOSA, S.L	ATXONDO	VIZCAYA
FUCHS LUBRICANTES, S.A.U	CASTELLBISBAL	BARCELONA
FUJICAUCHO, S.L.	SANT ESTEVE SESROVIRES	BARCELONA
FUNDERIA CONDALS, S.A.	MANRESA	BARCELONA
FUNDICION INYECTADA BADALONA, S.A.	BADALONA	BARCELONA
FUNDICIONES DE ODENA, S. A.	ODENA	BARCELONA
FUNDICIONES DE VERA, S. A.	VERA DE BIDASOA	NAVARRA
FUNDICIONES INYECTADAS ALAVESAS, S.A.	NANCLARES DE LA OCA	ALAVA
FUNDICIONES MIGUEL ROS, S. A.	SANT VINCENT DELS HORTS	BARCELONA
GALVANIZACIONES CASTELLANA	DUEÑAS	PALENCIA
GAMEKO FABRICACION DE COMPONENTES SA (CIE	LEGUTIANO	ALAVA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
GAMEKO)		
GATES P.T. SPAIN, S.A.	BALSARENY	BARCELONA
GE LIGHTING APPLIANCES ESPAÑA, S.A.	GETAFE	MADRID
GECOINSA - GESTORA COMERCIAL INTERNACIONAL, S.L.U	VALDEMORO	MADRID
GEDINBA, S. A. (ANTES AUTOPULIT)	SAINT FRUITOS DE BAGES	BARCELONA
GESTAMP NAVARRA	ORCOYEN	NAVARRA
GESTAMP AUTOMOCION	MADRID	MADRID
GESTAMP BIZKAIA	ABADIANO	VIZCAYA
GESTAMP CATAFORESIS VIGO	VIGO	PONTEVEDRA
GESTAMP ESMAR ZP	BARCELONA	BARCELONA
GESTAMP I+D	AMOREBIETA-ETXANO	VIZCAYA
GESTAMP LINARES	LINARES	JAEN
GESTAMP PALENCIA	DUEÑAS	PALENCIA
GESTAMP TOLEDO	SESEÑA NUEVO	TOLEDO
GESTAMP VIGO	PORRIÑO	PONTEVEDRA
GKN DRIVELINE	BARBERA DEL VALLES	BARCELONA
GKN DRIVELINE VIGO, S. A.	VIGO	PONTEVEDRA
GKN DRIVELINE ZUMAYA	ZUMAYA	GUIPUZCOA
GKN DRIVELINES LEGAZPI	LEGAZPI	GUIPUZCOA
GKN-AYRA CARDAN, S.A.	DEBA	GUIPUZCOA
GOIPLASTIK, S.L.	SAN SEBASTIAN	GUIPUZCOA
GONVARRI I. CENTRO DE SERVICIOS BURGOS	BURGOS	BURGOS
GONVARRI I. CENTRO DE SERVICIOS, S.L.	MADRID	MADRID
GONVAUTO BARCELONA	CASTELLBISBAL	BARCELONA
GONVAUTO NAVARRA	NOAIN	NAVARRA
GONVAUTO, S.A.	CASTELLBISBAL	BARCELONA
GOODYEAR DUNLOP TIRES, S.A.	MADRID	MADRID
GORVI, S.A.	PAMPLONA	NAVARRA
GOVESAN, S.A.U	COLMENAR VIEJO	MADRID
GPI ESPAÑA.SLU	SANT ANDRES DE LA BARCA	BARCELONA
GRACE, S.A.	SANT BOI DE LLOBREGAT	BARCELONA
GRAMMER AUTOMOTIVE ESPAÑA, S.A.	OLERDOLA	BARCELONA
GRUPELEC ELECTRONICA	BOECILLO	VALLADOLID
GRUPO AITANA LEVANTE, S.L.	CAUDETE	ALBACETE
GRUPO ANTOLIN-ALAVA, S.L.	VITORIA	ALAVA
GRUPO ANTOLIN-ARA, S.L.	BURGOS	BURGOS
GRUPO ANTOLIN-ARAGUSA, S.A.	BURGOS	BURGOS
GRUPO ANTOLIN-AUTOTRIM, S.A.	BARCELONA	BARCELONA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
GRUPO ANTOLIN-AUTOTRIM, S.A.U	ALMUSAFES	VALENCIA
GRUPO ANTOLIN-DAPSA, S.A.	BURGOS	BURGOS
GRUPO ANTOLIN-EUROTRIM, S.A.	BURGOS	BURGOS
GRUPO ANTOLIN-INGENIERIA, S.A.	BURGOS	BURGOS
GRUPO ANTOLIN-IRAUSA, S.A.	BURGOS	BURGOS
GRUPO ANTOLIN-LINARA, S.A.	LINARES	JAEN
GRUPO ANTOLIN-MARTORELL, S.A.	SAN ESTEVE SESROVIERES	BARCELONA
GRUPO ANTOLIN-NAVARRA, S.A.	ARAZURI	NAVARRA
GRUPO ANTOLIN-PGA, S.A.	PORRIÑO	PONTEVEDRA
GRUPO ANTOLIN-PLASBUR, S.A	BURGOS	BURGOS
GRUPO ANTOLIN-RYA, S.A.	VALLADOLID	VALLADOLID
GRUPO CAUTEX, S.L. (FLEXO)	SANT FELIU DE LLOBREGAT	BARCELONA
GRUPO COMPONENTES VILANOVA S.L. (CIE C. VILANOVA)	VILANOVA I LA GELTRU	BARCELONA
GRUPO CROPU, S.L.	BURGOS	BURGOS
GRUPO ESTAMPACIONES SABADELL PLANTA POLINYA	PALAU-SOLITA I PLEGAMANS	BARCELONA
GRUPO ESTAMPACIONES SABADELL, S. A. - PLANTA PALAU	PALAU DE PLEGAMANS	BARCELONA
GRUPO GENERAL CABLE SISTEMAS SA	BARCELONA	BARCELONA
GRUPO GONVARRI	MADRID	MADRID
GRUPO MZ	ABADIANO	VIZCAYA
GRUPOS DIFERENCIALES, S.A.	VITORIA	ALAVA
GRYYP LINE, S.L.	SANT JUST DESVERN	BARCELONA
GSB-TBK AUTOMOTIVE COMPONENTES,S.L.	VILANOV I LA GELTRU	BARCELONA
GUARDIAN LLODIO UNO, S. L.	LLODIO	ALAVA
GUILERA, S.A.	MOLINS DE REI	BARCELONA
HALDE GAC, SDAD. LTDA.	BARCELONA	BARCELONA
HELLA, S.A.	TRES CANTOS	MADRID
HENKEL IBERICA, S.A.-DIVISIÓN MC/AIA	BARCELONA	BARCELONA
HERMANOS SANCHEZ-LAFUENTE, S.A.	CAMPANILLAS	MALAGA
HIASA	CORBERA	ASTURIAS
HIERROS Y APLANACIONES, S.A.	CORVERA DE ASTURIAS	ASTURIAS
HOFMANN INNOVATION IBERICA, S.A.	MARTORELL	BARCELONA
HOFMANN TECNICA DEL EQUILIBRADO, S.L.	ZARAGOZA	ZARAGOZA
HONEYWELL FRICCION ESPAÑA, S.A. UNIPERSONAL	BARCELONA	BARCELONA
HUF ESPAÑA, S.A.	EL BURGO DE OSMA	SORIA
HUTCHINSON INDUSTRIAS DEL CAUCHO, S.A.	ARGANDA DEL REY	MADRID
HUTCHINSON PALAMOS. S.A.	PALAMOS	GERONA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
IAC GROUP, S.L.(INT. AUTOMOTIVE COMPONENTS GROUP)	AGONCILLO (LA RIOJA)	LA RIOJA
IAC GROUP, S.L.(INT.AUTOMOTIVE COMPONENTS GROUP)	VITORIA	ALAVA
IADA, S.L.	VILOBI DEL PENEDES	BARCELONA
IBERICA DE SUSPENSIONES, S.L.	ALSASUA	NAVARRA
ICER BRAKES, S.A.	PAMPLONA	NAVARRA
ICOA, S.A.	BILBAO	VIZCAYA
IDENMOVIL, S.L.	SILLA	VALENCIA
IDESA ACCESORIOS, S.A.	SANT BOI DE LLOBREGAT	BARCELONA
IDIADA AUTOMOTIVE TECHNOLOGY, S.A.	SANTA OLIVA	TARRAGONA
IGURIA, S.A.	ELORRIO	VIZCAYA
IKOR SISTEMAS ELECTRONICOS, S.A.	SAN SEBASTIAN	GUIPUZCOA
IMA 1, S.L. -INDUSTRIA MECANICA AUTOMATICA	BURGOS	BURGOS
INAC EXPORT, S.L.	SANT FOST DE CAMPSENTELLES	BARCELONA
INCAELEC S.L. (CABLEADOS ELECTRICOS)	ZARAGOZA	ZARAGOZA
INDECO AUTOMOVIL EUROPA SL	MALAGA	MALAGA
INDUSTRIAL ARCOL, S.A.	LA ROCA DEL VALLES	BARCELONA
INDUSTRIAL CONTROLLER	MATARO	BARCELONA
INDUSTRIAL DE TECNICA Y PRECISION, S.A.	CORNELLA DE LLOBREGAT	BARCELONA
INDUSTRIAL DE TRANSFORMADOS, S.A. - ITSA	L'ARBOS DEL PENEDES	TARRAGONA
INDUSTRIAL ELECTROLITICA CANO, S.L .INELCA	SANT ESTEVE SESROVIRES	BARCELONA
INDUSTRIAL FLEXO, S.L	SANT JUST DESVERN	BARCELONA
INDUSTRIAL OLLE TORNER, S.L.-INDOPLAST	RUBI	BARCELONA
INDUSTRIAS ALEGRE, S.A.	ALBAL	VALENCIA
INDUSTRIAS ALGA, S.A.	ABADIANO	VIZCAYA
INDUSTRIAS ALZUARAN, S.L.	ZALDIVAR	VIZCAYA
INDUSTRIAS AMAYA TELLERIA, S.A.	ERMUA	VIZCAYA
INDUSTRIAS COUSIN FRERES, S.L. (FAURECIA)	BURLADA	NAVARRA
INDUSTRIAS DE DECOLETAJE Y ESTAMPACION,S.L	ERMUA	VIZCAYA
INDUSTRIAS DEL CAUCHO, S. A.	PAMPLONA	NAVARRA
INDUSTRIAS DEL RECAMBIO DISTRIBUCION, S.L.	EGÜES	NAVARRA
INDUSTRIAS DEL UBIERNA, S. A. -UBISA-	BURGOS	BURGOS
INDUSTRIAS DOLZ	CASTELLON DE LA PLANA	CASTELLON
INDUSTRIAS FEU, S.L.	POLINYA	BARCELONA
INDUSTRIAS GALFER - GALFER AUTO	GRANOLLERS	BARCELONA
INDUSTRIAS GOL, S.A.U..	PLACENCIA DE LAS ARMAS	GUIPUZCOA
INDUSTRIAS GONAL HISPANIA, S.L.	LAS FRANQUESAS DEL VALLÉS	BARCELONA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
INDUSTRIAS J. FERRER - PLANTA EST METALICA	BONREPOS	VALENCIA
INDUSTRIAS J. FERRER - PLANTA FORJA Y FUNDICION	BONREPOS	VALENCIA
INDUSTRIAS J. FERRER - PLANTA MECANIZADO	BONREPOS	VALENCIA
INDUSTRIAS J. FERRER, S. A.	BONREPOS	VALENCIA
INDUSTRIAS J. SARDAÑES, S.L.	SANT ANDRES DE LA BARCA	BARCELONA
INDUSTRIAS MECANICAS JEFRA, S.L.	ALMUSSAFES	VALENCIA
INDUSTRIAS OCHOA, S.L.	RIBARROJA	VALENCIA
INDUSTRIAS PLASTICAS TRILLA, S. A.	ALCALÁ DE HENARES	MADRID
INDUSTRIAS QUIMICAS NABER, S.A.	BENIPARRELL	VALENCIA
INDUSTRIAS REHAU, S.A.	GAVA	BARCELONA
INDUSTRIAS SALUDES, S.A.U	ALCASSER	VALENCIA
INDUSTRIAS SAMART, S.A.	FIGUERES	GERONA
INDUSTRIAS ZELU, S.L. (KLAM)	ARRE	NAVARRA
INDUSTRIE ILPEA ESPAÑA, S. A.	POLINYA	BARCELONA
INERGY AUTOMOTIVE SYSTEMS, S.A.	GONDOMAR	PONTEVEDRA
INEXCO-TRADING, S.A.	MADRID	MADRID
INFUN, S.A.	SANT VICENÇ DELS HORTS	BARCELONA
INGARSA	OLITE	NAVARRA
INGENIERIA GLOBAL METALBAGES	SANTPEDOR	BARCELONA
INKATOR, S.A.	RUBI	BARCELONA
INLISA	BARCELONA	BARCELONA
INSONORIZANTES PELZER , S.A.	ZARAGOZA	ZARAGOZA
INSTITUTO ANDALUZ DE TECNOLOGIA	SEVILLA	SEVILLA
INTECSA - INDUSTRIAS TECNICAS DE LA ESPUMA (HUTCHI	ARMIÑON	ALAVA
INTERNACIONAL HISPACOLD, S.A.	SEVILLA	SEVILLA
INTEVA PRODUCTS ESPAÑA, S. A.	SANTA MARIA DE PALAUTORDERA	BARCELONA
INTIER AUTOMOTIVE INTERIORS ZIPPEX, S.A.	POLINYA	BARCELONA
INYECTAMETAL, S. A. (CIE INYECTAMETAL)	ABADIANO	VIZCAYA
IQAP MASTERBATCH GROUP	MASIES DE RODA	BARCELONA
IRUÑA RECAMBIOS DE FRENOS, S.L.	BARBATAIN-GALAR	NAVARRA
ISRINGHAUSEN SPAIN	PAMPLONA	NAVARRA
ISTOBAL, S. A.	L'ALCUDIA	VALENCIA
ITAL RECAMBIOS, S. A.	MADRID	MADRID
ITM - INFORMACIÓN, TECNOLOGÍA Y MERCADO, S.A.U	ZARAGOZA	ZARAGOZA
ITW ESPAÑA, S. A.	LES FRANQUESES DEL VALLES	BARCELONA
J.JUAN, S.A.	GAVA	BARCELONA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
J.L. FRENCH ANSOLA, S.L.	ETXEBARRI	VIZCAYA
JABER, S.A.	MOSTOLES	MADRID
JAL INDUSTRIA AUXILIAR DE MECANIZACION	PINTO	MADRID
JEGAN, S.A.L.	ITZIAR-DEBA	GUIPUZCOA
JESUS OÑATE Y HERMANOS, S.A.	DURANGO	VIZCAYA
JJL SEGURIDAD AUTOMOCION, S.L.	SAN SEBASTIAN DE LOS REYES	MADRID
JOARJO, S.L.	PUEBLA DE ALFINDEN	ZARAGOZA
JOHN DEERE IBERICA, S.A.	GETAFE	MADRID
JOHNSON CONTROLS ALAGON S.A.V.	ALAGON	ZARAGOZA
JOHNSON CONTROLS AUTOBATERIAS, S.A.	MADRID	MADRID
JOHNSON CONTROLS EUROSIT, S.L.	ABRERA	BARCELONA
JOHNSON CONTROLS IBERICA	AGULLENT	VALENCIA
JOHNSON CONTROLS VALLADOLID, S.A. UNIPERSONAL	MOJADOS	VALLADOLID
JORDAN MARTORELL, S.L.	MARTORELL	BARCELONA
JOST IBERICA, S.A.	ZARAGOZA	ZARAGOZA
JUMASA PARTS S.L.U.	SONDIKA	VIZCAYA
JUNTA 3, S.L.	RIVA ROJA DEL TURIA	VALENCIA
KAMAX TUSA, S.A.	MUSEROS	VALENCIA
KANSEI SPAIN , S.A.	OLERDOLA	BARCELONA
KATAFORESIS BURGOS, S.A.	BURGOS	BURGOS
KAUFIL SEALING TECHNOLOGIES	LOGROÑO	LA RIOJA
KAUTEX TEXTRON IBERICA, S.L.	PALAU DE PLEGAMANS	BARCELONA
KEIPER IBERICA S.A.	CALATORAO	ZARAGOZA
KIT PERSONALIZACION SPORT, S.L.-KP SPORT	MONTMELO	BARCELONA
KOSTAL ELECTRICA, S.A.	SENTMENAT	BARCELONA
KOYO BEARINGS	BILBAO	VIZCAYA
KOYO IBERICA, S.L	COSLADA	MADRID
KRAFFT, S.A.	ANDOAIN	GUIPUZCOA
KUSTER ESPAÑA, S.A.	RIPOLLET	BARCELONA
KYB EUROPE GMBH SUCURSAL EN ESPAÑA	ALCALÁ DE HENARES	MADRID
KYB STEERING SPAIN	ORCOYEN	NAVARRA
KYB SUSPENSIONS EUROPE, S.A.	ORORBIA	NAVARRA
L & D AROMATICOS, S.A.	HUERCAL DE ALMERIA	ALMERIA
LA UNION METALURGICA, S.A.	BARCELONA	BARCELONA
LAHNWERK RUBI, S. A.U	ABRERA	BARCELONA
LAMINACION VIZCAYA, S.L	SAN MIGUEL DE BASAURI	VIZCAYA
LAMINADOS LOSAL, S.A.	GUERNICA	VIZCAYA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
LARZEP, S. A.	MALLAVIA	VIZCAYA
LCN MECANICA, S.L.	GUADALAJARA	GUADALAJARA
LEAR AUTOMOTIVE (EEDS) SPAIN, S.L.	VALLS	TARRAGONA
LEAR CORPORATION ASIENTOS, S.L.	EPILA	ZARAGOZA
LEBO, S.L.U.	LLEIDA	LÉRIDA
LECIÑENA, S.A.	UTEBO	ZARAGOZA
LEXTON, S.L.	ZARAGOZA	ZARAGOZA
LGAI TECHNOLOGICAL CENTER, S.A.	BELLATERRA	BARCELONA
LINDE Y WIEMANN, S.A.	LA GARRIGA	BARCELONA
LINGOTES ESPECIALES S.A.	VALLADOLID	VALLADOLID
LISI AUTOMOTIVE KNIPPING ESPAÑA	FUENLABRADA	MADRID
LITE ENERGY ESPAÑA, S.A.	ODENA	BARCELONA
LIZARTE, S.A.	PAMPLONA	NAVARRA
LONGWOOD ELASTOMERS, S.A.	SORIA	SORIA
LUGER CENTRO DE CORTE, S.L.	ARGANDA DEL REY	MADRID
MAGNA DONNELLY ESPAÑA, S.A.	POLINYA	BARCELONA
MAGNETI MARELLI ELECTRONICA, S.L.	BARBERA DEL VALLES	BARCELONA
MAHLE AFTERMARKET, S.L.	ALCALA DE HENARES	MADRID
MAHLE BEHR SPAIN, S.A.	MONTBLANC	TARRAGONA
MAHLE, S.A.	VILANOVA I LA GELTRU	BARCELONA
MAIER, S.COOP.	GUERNICA	VIZCAYA
MAIN-METALL ESPAÑOLA, S.L.	TORRELAVEGA	CANTABRIA
MANAD, S.A.	BARCELONA	BARCELONA
MANIPULADOS ELECTRICOS, S.L.-COELEC	PRAT DE LLOBREGAT	BARCELONA
MANN HUMMEL IBERICA, S.A.	ZARAGOZA	ZARAGOZA
MANUFACTURA MODERNA DE METALES, S.A.	MOLINS DE REI	BARCELONA
MANUFACTURAS CRUCE, S.A.	PINTO	MADRID
MANUFACTURAS WRAKYNSON	LERIDA	LERIDA
MANUFACTURAS Y ACCESORIOS ELECTRICOS, S.A. (MAESA)	TORREJON DE ARDOZ	MADRID
MAPRO SISTEMAS DE ENSAYO, S.A.	SANT FRUITOS DEL BAGES	BARCELONA
MAPSA, S. COOP.	ORCOYEN	NAVARRA
MARTINREA HONSEL SLU	MOSTOLES	MADRID
MASATS, S.A.	SANT SALVADOR DE GUARDIOLA	BARCELONA
MATE COMPAC SL	NÁQUERA	VALENCIA
MATIENA-FEPA, S.L.	ABADIANO	VIZCAYA
MATRICES Y MOLDES, J.F.M., S.A.	SAN VICENT DELS HORTS	BARCELONA
MATRICI, S. COOP. LTDA.	ZAMUDIO	VIZCAYA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
MATRIPLAS, S.L.	PARACUELLOS DEL JARAMA	MADRID
MATRIVAL, S.L.	BENIPARRELL	VALENCIA
MAXIMA TECHNOLOGIES SL	RUBI	BARCELONA
MAXION WHEELS	MANRESA	BARCELONA
MB ABRERA, S.A.	SANTPEDOR	BARCELONA
MB ARAGON	PEDROLA	ZARAGOZA
MB HIDROACERO	ORCOYEN	NAVARRA
MB LEVANTE	ALMUSAFES	VALENCIA
MB SANTPEDOR	SANTPEDOR	BARCELONA
MECALBE, S.A.	MALLAVIA	VIZCAYA
MECANER,S.A.	URDULIZ	VIZCAYA
MECANICAS DE LA SERNA, S.A.	ZARAGOZA	ZARAGOZA
MECANIZACIONES DEL SUR MECASUR, S.A. (CIE MECASUR)	VITORIA	ALAVA
MECANIZADOS DE CALIDAD, S.A.. - MECALSA	LEGUTIANO-VILLARREAL DE ALAVA	ALAVA
MECANIZADOS INDUSTRIA AUXILIAR, S.A.-MIASA-	PAMPLONA	NAVARRA
MECAPAL, S.L.	OÑATE	GUIPUZCOA
MECAPLAST IBERICA S.AU	SESEÑA	TOLEDO
MEDINABI RODAMIENTOS, S. L.	MADRID	MADRID
MEGATECH INDUSTRIES AMURRIO, S.L.	AMURRIO	ALAVA
MELCHOR GABILONDO, S. A.	BERRIZ	VIZCAYA
METAGRA BERGARA, S.A.	VERGARA	GUIPUZCOA
METALBAGES, S.A.	SANTPEDOR	BARCELONA
METALOR IBERICA, S.A.	BARCELONA	BARCELONA
METALURGICA MADRILEÑA, S.A.	ALCALA DE HENARES	MADRID
MGI COUTIER, ESPAÑA SLU	VIGO	PONTEVEDRA
MICHELIN ESPAÑA PORTUGAL, S.A.	TRES CANTOS	MADRID
MIGUELEZ, S.L.	LEON	LEON
MIJU, S.A.	ZARAGOZA	ZARAGOZA
MILLARD FILTERS IBERICA, S.L.	LAS ROZAS DE MADRID	MADRID
MOBIS PARTS EUROPE NV, SUCURSAL ESPAÑA	MECO	MADRID
MOELSI, S.A.	VILASSAR DE DALT	BARCELONA
MONDRAGON AUTOMOCION, S. COOP.	ARRASATE	GUIPUZCOA
MOTHERSON SINTERMETAL PRODUCTS, S.A.	RIPOLLET	BARCELONA
MP AERONAUTICA	SEVILLA	SEVILLA
MP TUBOS DE GOMA, S.L.	MONTMELO	BARCELONA
MRB ENGRANAJES	POLINYA	BARCELONA
MUELLES Y BALLESTAS HISPANO ALEMANAS, S.A.	VILLARREAL DE LOS	CASTELLON

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
	INFANTES	
NAGARES, S. A.	MOTILLA DEL PALANCAR	CUENCA
NATAN SL	SANT ADRIA DE BESOS	BARCELONA
NEDERLANDSE RADIATEUREN FABRIEX ESPAÑA S.A.	PELIGROS	GRANADA
NEDSSHROES BARCELONA SAU	SANT JOAN DESPI	BARCELONA
NEOTRONIC, S.A.	MONTCADA I REIXACH	BARCELONA
NER-TOR, S.A.	OLESSA DE MONTSERRAT	BARCELONA
NEUMARSA-EXPORT	BARCELONA	BARCELONA
NEXANS IBERIA, S.L.	POLINYA	BARCELONA
NGK SPARK PLUG EUROPE GMBH (SUCURSAL EN ESPAÑA)	SANT JUST DESVERN	BARCELONA
NOBEL PLASTIQUES IBERICA, S. A.	SANT JOAN DESPI	BARCELONA
NOVA RANK S.L.	BARCELONA	BARCELONA
NOVA RECYD, SAU (CIE NOVA RECYD)	LEGUTIANO	ALAVA
NTN-SNR IBERICA, S. A.	MADRID	MADRID
NUCAP EUROPE, S.A.	ARAZURI	NAVARRA
OETIKER ESPAÑA, S. A.	EL PUERTO DE SANTA MARIA	CADIZ
OLIPES, S.L.	CAMPO REAL	MADRID
OMNIA MOTOR, S.A.	BARCELONA	BARCELONA
OMRON ELECTRONICS, S.A.	MADRID	MADRID
ONYX OIL LUBRICANTES, S.L.	SANT QUIRZE DEL VALLES	BARCELONA
ORBELAN PLASTICOS, S.A. (CIE ORBELAN)	ANDOAIN	GUIPUZCOA
OSRAM, S.A.	TORREJON DE ARDOZ	MADRID
OTZA MACHARIA, S.A.	LOGROÑO	LA RIOJA
PANEL FIJACIONES, S.COOP.	TOLOSA	GUIPUZCOA
PARKER HANIFFIN ESPAÑA, S.L	TORREJON DE ARDOZ	MADRID
PEDRO ROQUET, S.A.	TONA	BARCELONA
PEIMER, S.A.	PUERTO DE SANTA MARIA, EL	CÁDIZ
PETRONAS LUBRICANTES SPAIN SLU	CANOVELLES	BARCELONA
PHILIPS IBERICA SAU-DIVISION ALUMBRADO	MADRID	MADRID
PHIRA COMPONENTES AUTOMOCION, S.A.	SANT JOAN DESPI	BARCELONA
PIERBURG, S.A.	ABADIANO	VIZCAYA
PILKINGTON AUTOMOTIVE ESPAÑA S.A	SAGUNTO	VALENCIA
PINTURAS VICAR, S.A.	PINTO	MADRID
PIRELLI NEUMATICOS, S.A.U.	BARCELONA	BARCELONA
PLASTICOS ABC SPAIN, S.A.	SORIA	SORIA
PLASTICOS BRELLO, S. A.	HUARTE	NAVARRA
PLASTICOS GETAFE INDUSTRIAL, S. A. (PLASGEIN)	FUENLABRADA	MADRID
PLASTO ADHESIVOS IBERICA, S.L.	PORRIÑO	PONTEVEDRA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
PMG ASTURIAS POWDER METAL, S.A.U.	MIERES	ASTURIAS
PMG POLMETASA, SAU	MONDRAGON	GUIPUZCOA
POLIURETANO MOLDEADO, S.L.	CARTAGENA	MURCIA
POLYONE ESPAÑA SL	BARBASTRO	HUESCA
POWER PACKER ESPAÑA, S. A.	TORRIJOS	TOLEDO
PPG IBERICA, S.A.	RUBI	BARCELONA
PRICEWATERHOUSE COOPERS, ASESORES DE NEGOCIOS, S.L	MADRID	MADRID
PROCOAT TECNOLOGIAS, S.L.	CASTELLGALI	BARCELONA
PRODUCTOS CONCENTROL, S.A.	RIUDELLOTS DE LA SELVA	GERONA
PRODUCTOS PLASTICOS PEFORMANTES 3.P., S.A.	RIBA-ROJA DE TURIA	VALENCIA
PROMA HISPANIA, S.A.	EPILA	ZARAGOZA
PROQUISUR, S.L.	RUTE	CORDOBA
PROSEAT FOAM MANUFACTURING SL	SANTPEDOR	BARCELONA
PROYECTOS Y PRODUCCIONES CYAN S.A.	MADRID	MADRID
PYMASA -PIEZAS Y MECANISMOS DE AUTOMOCION,SA.	FUENLABRADA	MADRID
QUIMIBERICA, S.A.	ARRUBAL	LA RIOJA
QUIMILOCK, S.A.	GETAFE	MADRID
RADIADORES ORDOÑEZ, S.A.	CASTELLON DE LA PLANA	CASTELLON
RAYTHEON MICROELECTRONIC ESPAÑA, S.A.	CAMPANILLAS	MALAGA
RECAUCHUTADOS MESAS, S.A.	ALBACETE	ALBACETE
RECYDE SAU (CIE RECYDE)	ELGUETA	GUIPUZCOA
RELATS, S.A.	CALDES DE MONTBUI	BARCELONA
RELEVOR IZARRA SAU	IZARRA	ALAVA
RENOLIT IBERICA	SANT CELONI	BARCELONA
RIALS, S.A.	TORREJON DE ARDOZ	MADRID
RIBAWOOD, S.A.	VILLANUEVA DE GALLEGO	ZARAGOZA
RICARDO PREHN, S.A.	CASTELLBISBAL	BARCELONA
RINDER INDUSTRIAL, S.A.	GUERNICA	VIZCAYA
ROBERLO, S.A.	SANTA CRISTINA DE HARO	GERONA
ROBERLO, S.A.	RIUDELLOTS DE LA SELVA	GERONA
ROBERT BOSCH ESPAÑA, S.L.U.	MADRID	MADRID
ROBERT BOSCH ESPAÑA-FABRICA CASTELLET, S.A.	VILAFRANCA DEL PENEDES	BARCELONA
ROBERT BOSCH ESPAÑA-FABRICA MADRID, S.A.	MADRID	MADRID
ROBERT BOSCH ESPAÑA-FABRICA TRETO,S.A.	TRETO	CANTABRIA
ROBERT BOSCH GASOLINE SYSTEMS SA	ARANJUEZ	MADRID
ROEIRASA, S.A.	GETAFE	MADRID
RONAL IBERICA, S.A.	TERUEL	TERUEL

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
RPK METAL FORMING S.A.U.	TARRAGONA	TARRAGONA
RPK, S.COOP.	VITORIA	ALAVA
RTS, S.A.	MENDARO	GUIPUZCOA
RUBBERMOLD, S.L.	VILADECANS	BARCELONA
RUFFINI, S.A.	RUBI	BARCELONA
RYME-TECNICAS REUNIDAS DE AUTOMOCIÓN,S.A	BURGOS	BURGOS
S. A. MASATS	SAN SALVADOR DE GUARDIOLA	BARCELONA
S.A. METALOGRAFICA	CERDANYOLA	BARCELONA
SA DE TUERCAS	ABADIANO	VIZCAYA
SADECA SYSTEMS SLU	SENTMENAT	BARCELONA
SAGOLA, S.A.	VITORIA	ALAVA
SAINT-GOBAIN SEKURIT	MADRID	MADRID
SAMOA INDUSTRIAL, S.A.	GIJON	ASTURIAS
SANDHAR TECHNOLOGIES BARCELONA	SANTA MARGARIDA I ELS MONJOS	BARCELONA
SANTIAGO SALABERRIA, S.A.	YURRETA	VIZCAYA
SAPA EXTRUSION LA SELVA, S.L.	LA SELVA DE CAMP	TARRAGONA
SCHADE AUTOMOCIÓN S.A.	EGÜES	NAVARRA
SCHAEFFLER IBERIA SLU	SAN AGUSTIN DE GUADALIX	MADRID
SCHOTT IBERICA, S.A.	SANT ADRIA DE BESOS	BARCELONA
SCHUNK IBERICA, S.A.	PINTO	MADRID
SEAT COMPONENTES (GEARBOX DEL PRAT, S.A.)	EL PRAT DE LLOBREGAT	BARCELONA
SEGURIDAD INDUSTRIAL SEINSA	EUGUI	NAVARRA
SEINSA - SEGURIDAD INDUSTRIAL, S.A.	EUGUI	NAVARRA
SERCORE TECH, S.L.	DAGANZO DE ARRIBA	MADRID
SIDENOR INDUSTRIAL SL	VITORIA	ALAVA
SILENCIOSOS ASTEASU SLL	ASTEASU	GUIPUZCOA
SILENCIOSOS FALCES, S.A.	FALCES	NAVARRA
SINTERIZADOS MONTBLANCH, S.A. -SIMO-	SANT FELIU DE LLOBREGAT	BARCELONA
SISTEMAS MECANICOS AVANZADOS, S.L.	ERANDIO	VIZCAYA
SKF ESPAÑOLA, S.A.	ALCOBENDAS	MADRID
SMP AUTOMOTIVE TECHNOLOGY IBERICA, S.L.	POLINYA	BARCELONA
SOGEFI FILTRATION, S.A.	CERDANYOLA DEL VALLES	BARCELONA
SOLBLANK, S.A.	CASTELLBISBAL	BARCELONA
SOME, S.A.	SANT QUIRZE DE BESORA	BARCELONA
SRG GLOBAL LIRIA, S.L.	LLIRIA	VALENCIA
STABILIS GMBH - OFICINA ESPAÑA	DERIO	VIZCAYA
STADLER, S.A.	OÑATE	GUIPUZCOA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
STAGI INTERNACIONAL, S.A.	MADRID	MADRID
STUKA, S.A.	IZURZA	VIZCAYA
SUMEX, S.A.	SAN JOAN DESPI	BARCELONA
SYSTEM & MANUFACTRING SPAIN, S.A. (SMS)	MANZANARES	CIUDAD REAL
T. FIXTOR, S.A.	RENTERIA	GUIPUZCOA
TAB SPAIN, S.L.	BARBERA DEL VALLES	BARCELONA
TALLERES AUXILIARES DE ESTAMPACIONES - TADE	SABADELL	BARCELONA
TALLERES BRIMO, S.A.	GRANOLLERS	BARCELONA
TALLERES DE ESCORIAZA	SAN FERNANDO DE HENARES	MADRID
TALLERES LORES, S.A. - TALOSA	EGÜES	NAVARRA
TALLERES ORAN, S. L.	SANTANDER	CANTABRIA
TALLERES PROTEGIDOS GUREAK, S.A.	SAN SEBASTIAN	GUIPUZCOA
TALLERES RICARDO GARCIA, S.L.	ARGANDA DEL REY	MADRID
TARABUSI, S. A.	YGORRE	VIZCAYA
TEAASA - TECNICOS AUTOMOTRICES ASOCIADOS, S. A.	LA PUEBLA DE ALFINDEN	ZARAGOZA
TECNO DESIGN, S.L.	TEIÀ	BARCELONA
TECNOCONFORT, S. A.	PAMPLONA	NAVARRA
TEIN CENTRO TECNLOGICO DEL PLASTICO-TCTP	VALLS	TARRAGONA
TEKNIA AZUQUECA (IBEROFON PLASTICOS)	AZUQUECA DE HENARES	GUADALAJARA
TEKNIA ELORRIO SL	ELORRIO	VIZCAYA
TEKNIA ELORRIO, S.L.	EIBAR	GUIPUZCOA
TEKNIA INDECO SA	ASUA-ERANDIO	VIZCAYA
TEKNIA MARTOS SLU	MARTOS	JAEN
TEKNIA MARTOS SLU	MARTOS	JAEN
TENNECO AUTOMOTIVE IBERICA , S.A. (DIVI. FONOS)	ERMUA	VIZCAYA
TENNECO AUTOMOTIVE IBERICA, S.A.	ERMUA	VIZCAYA
TENNECO AUTOMOTIVE IBERICA, S.A.	ERMUA	VIZCAYA
TESA TAPE SA	ARGENTONA	BARCELONA
THYSSENKRUPP MATERIALS IBERICA, S.A.	MARTORELL	BARCELONA
TI GROUP AUTOMOTIVE SYSTEMS, S.A.(SOC.UNIPERSONAL)	MONTORNES DEL VALLES	BARCELONA
TM BELLVEI DECOLETAJE, S. A.	BELLVEI	TARRAGONA
TMD FRICTION ESPAÑA, S.L.SOCIEDAD UNIPERSONAL	CORNELLA	BARCELONA
TORNILLERIA DEBA, SAL	VERGARA	GUIPUZCOA
TORNIPLASA, S.L.L.	VITORIA	ALAVA
TORRES CAR MARKETING, S.L.	CASTELDEFELS	BARCELONA
TORUNSA, S.A.	VERGARA	GUIPUZCOA
TRABAZOLA, S.A.	BILBAO	VIZCAYA

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
TRANSFORMACIONES METALURGICAS NORMA, S.A.(CIENORMA	ITZIAR-DEBA	GUIPUZCOA
TRANSFORMACIONES METALURGICAS, S.A.U	PREMIA DE MAR	BARCELONA
TRANSFORMADOS SINTETICOS	SAN VICENTE DEL RASPEIG	ALICANTE
TRELLEBORG AUTOMOTIVE SPAIN, S.A.	MARTORELL	BARCELONA
TRELLEBORG INEPSA, S.A.	PAMPLONA	NAVARRA
TRETY, S.A.	MAÇANET DE LA SELVA	GERONA
TRICLO, S.A.	SANT ANDRES DE LA BARCA	BARCELONA
TRIMPLAST, S.L.	BARBERA DEL VALLES	BARCELONA
TRW AUTOMOTIVE ESPAÑA SL	MADRID	MADRID
TRW AUTOMOTIVE ESPAÑA, S.L.	MADRID	MADRID
TRW AUTOMOTIVE ESPAÑA, S.L.	MADRID	MADRID
TRW AUTOMOTIVE ESPAÑA, S.L.	MADRID	MADRID
TRW AUTOMOTIVE ESPAÑA, S.L.A.	POZUELO DE ALARCON	MADRID
TRW AUTOMOTIVE ESPAÑA.S.L	MADRID	MADRID
TST - STAG, S.A.	MADRID	MADRID
TUBSA AUTOMOCION, S.L. -FLEX-N-GATE	SANT JUST DESVERN	BARCELONA
TUERCAS Y FIJACIONES TECNOLOGICAS, S.A.	CORNELLA DE LLOBREGAT	BARCELONA
TUNNING DESIGN, S.L.	SANT FOST DE CAMPSENTELLES	BARCELONA
TURBO 3 T.C., S.A.	SANT BOI DE LLOBREGAT	BARCELONA
TURBOMECANICA, S.A. (TURMESA)	GETAFE	MADRID
TYCO ELECTRONICS AMP ESPAÑA, S.A.	MONTCADA I REIXAC	BARCELONA
UBIPLAST, S.L.	BURGOS	BURGOS
UGARTEBURU, S.A.	MALLAVIA	VIZCAYA
UPM - INSIA	MADRID	MADRID
URBENI, S.L.	LA MUELA	ZARAGOZA
URSA IBERICA AISLANTES, S.A.	PLA DE SANTA MARIA, EL	TARRAGONA
USINOR IBERICA, S.A.	MADRID	MADRID
V.LUZURIAGA-USURBIL, S.A.	USURBIL	GUIPUZCOA
VALENCIA MODULOS DE PUERTA S.L.	ALMUSSAFES	VALENCIA
VALEO CLIMATIZACION, S. A.	MARTORELLAS	BARCELONA
VALEO ESPAÑA, S.A.- DIV. TRANSMISIONES	FUENLABRADA	MADRID
VALEO ESPAÑA,S.A.-DCION.NACIONAL ESPAÑA Y PORTUGAL	GETAFE	MADRID
VALEO ILUMINACION, S.A.	MARTOS	JAEN
VALEO SERVICE ESPAÑA, S.A.	GETAFE	MADRID
VALEO SISTEMAS DE SEGURIDAD Y DE CIERRE, S.A.	OLESA DE MONTSERRAT	BARCELONA
VALEO SISTEMAS ELECTRICOS, S.L.	MADRID	MADRID

RAZÓN SOCIAL	LOCALIDAD	PROVINCIA
VALEO TERMICO, S.A.	ZARAGOZA	ZARAGOZA
VALVULAS LAC, S.A.	TARRASA	BARCELONA
VB AUTOBATERIAS, S.A.	GUARDAMAR DE SEGURA	ALICANTE
VB AUTOBATERIAS, S.A.	BURGOS	BURGOS
VIGAR, S.A.	RUBI	BARCELONA
VIPIEMME ACCUMULATORI, S.P.A.	ISSO (BERGAMO)	
VISTEON, S.A.	IGUALADA	BARCELONA
VIZA AUTOMOCION	PORRIÑO	PONTEVEDRA
VIZA AUTOMOCION, S. A.U	PORRIÑO	PONTEVEDRA
VULCANIZADOS CAUCHO METAL, S.L. - VULCAM	LA LLAGOSTA	BARCELONA
WABCO ESPAÑA S.L.	SAN FERNANDO DE HENARES	MADRID
WALTER PACK, S.L.	IGORRE	VIZCAYA
WAT DIRECCIONES, S.A.	MALLABIA	VIZCAYA
WISCO ESPAÑOLA, S.A.	BETELU	NAVARRA
WITZENMANN ESPAÑOLA, S.A.	GUADALAJARA	GUADALAJARA
WOCO TECNICA SA	IRUN	GUIPUZCUA
YUASA BATTERY IBERIA, S.A.	COSLADA	MADRID
ZANINI AUTO GRUP, S.A.	PARETS DEL VALLES	BARCELONA
ZERTAN, S.A.	VILLATUERTA	NAVARRA
ZF LEMFÖRDER TVA, S.A	ERMUA	VIZCAYA
ZF SACHS ESPAÑA, S.A.	LEZAMA	VIZCAYA
ZF SERVICES ESPAÑA, S.A.U.	SANT CUGAT DEL VALLES	BARCELONA
ZF SERVICES ESPAÑA.S.A.U.	SANT CUGAT DEL VALLES	BARCELONA
ZGS FRENOS, S.L.	BARCELONA	BARCELONA
ZOEL MIR, S.L.	NOAIN	NAVARRA