



Three Essays on Open Innovation and Low/ Medium Technology Industries and Firms

Abd El salam M. A. El Rayyes

ADVERTIMENT. La consulta d'aquesta tesi queda condicionada a l'acceptació de les següents condicions d'ús: La difusió d'aquesta tesi per mitjà del servei TDX (www.tdx.cat) i a través del Dipòsit Digital de la UB (diposit.ub.edu) ha estat autoritzada pels titulars dels drets de propietat intel·lectual únicament per a usos privats emmarcats en activitats d'investigació i docència. No s'autoritza la seva reproducció amb finalitats de lucre ni la seva difusió i posada a disposició des d'un lloc aliè al servei TDX ni al Dipòsit Digital de la UB. No s'autoritza la presentació del seu contingut en una finestra o marc aliè a TDX o al Dipòsit Digital de la UB (framing). Aquesta reserva de drets afecta tant al resum de presentació de la tesi com als seus continguts. En la utilització o cita de parts de la tesi és obligat indicar el nom de la persona autora.

ADVERTENCIA. La consulta de esta tesis queda condicionada a la aceptación de las siguientes condiciones de uso: La difusión de esta tesis por medio del servicio TDR (www.tdx.cat) y a través del Repositorio Digital de la UB (diposit.ub.edu) ha sido autorizada por los titulares de los derechos de propiedad intelectual únicamente para usos privados enmarcados en actividades de investigación y docencia. No se autoriza su reproducción con finalidades de lucro ni su difusión y puesta a disposición desde un sitio ajeno al servicio TDR o al Repositorio Digital de la UB. No se autoriza la presentación de su contenido en una ventana o marco ajeno a TDR o al Repositorio Digital de la UB (framing). Esta reserva de derechos afecta tanto al resumen de presentación de la tesis como a sus contenidos. En la utilización o cita de partes de la tesis es obligado indicar el nombre de la persona autora.

WARNING. On having consulted this thesis you're accepting the following use conditions: Spreading this thesis by the TDX (www.tdx.cat) service and by the UB Digital Repository (diposit.ub.edu) has been authorized by the titular of the intellectual property rights only for private uses placed in investigation and teaching activities. Reproduction with lucrative aims is not authorized nor its spreading and availability from a site foreign to the TDX service or to the UB Digital Repository. Introducing its content in a window or frame foreign to the TDX service or to the UB Digital Repository is not authorized (framing). Those rights affect to the presentation summary of the thesis as well as to its contents. In the using or citation of parts of the thesis it's obliged to indicate the name of the author.

PhD Thesis

**Three Essays on Open Innovation
and Low/ Medium Technology
Industries and Firms**

Abd El salam M. A. El Rayyes

PhD Supervisor

Dr. Jaume Valls Pasola

Business PhD Programme



Acknowledgements

I would like to offer my special thanks to Anna Balletbo i Puig, president of Olof Palme International Foundation - (FIOP). I wholeheartedly appreciate her solidarity project in Gaza, Palestine. Anna focused on Sustainable Development projects on Education and Social assistance. Al-karama Orphan House was her first project. Her second project was the Spanish Palestinian Institute, which gave opportunities to some Palestinians and encouraged them to survive based on the sustainable project approach. Thank you Anna for your solidarity projects in Gaza, Palestine.

My thanks also go to the Spanish Agency for International Cooperation and Development; (AECI). They offered me a scholarship and this gave me the opportunity to pursue my PhD at University of Barcelona, Department of Business Economics and Management. They gave me the chance to improve my life through education.

I am forever grateful to Dr. Jaume Valls Pasola, PhD coordinator of the UB Business Phd programme and supervisor of this thesis. Dr. Jaume has always been there for me and has dedicated his time to help me in my academic research. He thought me how to write a thesis and how to publish my article. Without his help it would have been impossible for me to publish my article and complete my thesis. We both faced challenging times throughout my research. My sincere appreciation goes for his continued support. Thank you Dr. Jaume.

I would like to thank Ms. Carme Luna, Coordinator at the Catalan Statistics Department, Statistical Institute of Catalonia (IDESCAT). Her spiritual support was indispensable to me. She opened her heart and office for me and gave me her email, so I could contact her at any time. She explained to me the system of (IDESCAT) and pointed out to the free lessons on the website. In sum, she proved the warm attitude of Catalan people; they are there for you whenever you need them.

My gratitude is also for Ms. Belen López from Fundacio Catalana per la Recerca i la Innovación – (FCRI). She gave me a chance and helping hands in the 2012 and 2013 seminars, she was extremely helpful and pleasant to deal with.

I am also indebted to Dr. Brett Trusko, Editor-in-Chief of International Journal of Innovation Science. Not only has Dr. Trusko assessed my article but also he gave me

chance correct my submitted article to his journal. Without his chance this article could not be published. He also gave me chance to deal with Nina Fazio, writer and copyeditor. I take this opportunity to thank her kindness.

My mother, father, grandmother while I should be the one to worry about them, they never deprive me of their full moral support. Without them, my study journey would have been a lonely one.

My enormous gratitude goes to my dear friends: Maha, Jamal and Franc, I can't deny their helps. How can anyone ever forget such loyal friends? No word can express my gratitude. Thanks all.

Barcelona, July 2014

Contents

Chapter 1	
Introduction	11

Chapter 2	
The Effect of Research & Development, Activities and Open Innovation Activities A Key To: Low/ Medium Technology Industries and Firms in Catalonia	19

Introduction	20
2.1. Literature Review	21
2.2. Conceptual Model and Hypotheses Formulation	23
2.2.1. Hypotheses	24
2.2.2. The Model	24
2.2.3. Main Characteristics of LMT Firms' Industrial Sector in Catalonia	25
2.3. Evidence from LMT Catalan Firms	28
2.3.1 Descriptive Statistics	28
2.3.2. Main Results	32
2.4. Concluding Remarks	33
2.5. References	35

Chapter 3	
Research and Development, University Research and Open Innovation: Towards an Implementation Process within Catalan Low and Medium Technology Firms	41

Introduction	42
3.1. The Framework	43
3.2. Key Characteristic of The Topic	46
3.3. Open Innovation Model	48
3.3.1. The Model of Implementing OI Activities in Catalan LMT Firms	49
3.3.2. The Benefit of OI Activities	50
3.3.3. Open Innovation and Practices	51
3.4. Implementation of OI Activities in Catalan LMT Firms	53
3.4.2. Evaluation of Catalan LMT Firms	53
3.4.3. The importance of R&D and UR Activities in LMT Firms	57
3.5. Discussion and Analysis	57
3.5.2. How does an open innovation tool develop solutions for LMT firms that can improve the performance through the implementation process in Catalan LMT firms?	58

3.5.3. What support do LMT firms require to implement OI processes and become OI firms?	59
3.6. Concluding Remarks	60
3.7. References	62

Chapter 4	
External Source of knowledge as an Open innovation (OI) tool: A comparison of Open-Alps Platform and the Catalan ICT Sector	69

Introduction	70
4.1. Literature Review	71
4.2. A case Study of Catalan ICT Sector and Open- Alps Platform.	73
4.2.1. A case Study	73
4.2.2. The Case Questions	74
4.2.3. Open Innovation Related Activities in Catalan, SMEs/ LMT Firms	75
4.2.4. Open Innovation Related Activities in Open- Alps, SMEs/ LMT Firms	76
4.3. Main characteristic of The Study	77
4.3.1. The Case of Open-Alps Platform	77
4.3.2. The Case of ICT Sector in Catalonia	80
4.3.3. Perspective of Missing Point: Are the use of external source of knowledge in Catalonia and Open-Alps related to OI concept activities?	83
4.4. Key Findings of Using of OI Concept Related Activities in Catalonia and Open- Alps SMEs/ LMT Firms	84
4.4.1. Key Finding on Catalan SMEs/ LMT Firms	85
4.4.2. Key Finding on Open- Alps SMEs/ LMT Firms	86
4.4.3. Perspective of Missing Point: How do Catalan and Open- Alps SMEs/ LMT firms identify useful external source of knowledge in their firms?	87
4.5. Concluding Remarks	90
4.6. References	92

Chapter 5	
Conclusion	97

References (in alphabetical order)	105
---	------------

Annex 1. Contribution of Intermediate	117
--	------------

Resum

El nostre treball s'ha centrat en el tema de la innovació i les PIMES. En concret hem investigat sobre l'efecte de la innovació oberta i la seva connexió amb els sectors d'intensitat tecnològica mitjana o baixa. Hem pres com a referència el cas català. S'ha analitzat tant el concepte com el model d'OI (Open Innovation), seguint l'enfocament del terme proposat per Henry Chesbrough l'any 2003.

Per a l'obtenció de les dades, hem fet servir una metodologia d'estadística descriptiva. El nostre estudi té com a objectiu descriure i explicar la diferència entre les empreses catalanes i realitats empresarials de països de la UE en un context de PIMES intensitat tecnològica mitja o baixa.

En aquest context de PIMES i sectors d'intensitat tecnològica mitja o baixa la nostra recerca mostra que el procés d'innovació a Catalunya es pot abordar en tres dimensions : l'efecte de les activitats d'OI , el procés d'implementació d'OI i la font externa de coneixement de la OI a les empreses catalanes. L'efecte de la implementació d'activitats d'OI dins del procés d'innovació industrial ha millorat significativament els darrers anys.

La investigació analitza l'èxit de diverses estratègies. Investiga la relació entre les activitats d'OI i les PIME de sectors d'intensitat mitja o baixa a Catalunya i proposa, algunes recomanacions per la desplegament de polítiques.

Resumen

Nuestro trabajo se ha centrado en el tema de la innovación y las Pymes. En concreto hemos investigado sobre el efecto de la innovación abierta y su conexión con los sectores de intensidad tecnológica media o baja. Se ha tomado como referencia el caso catalán. Se ha analizado tanto el concepto como el modelo de OI (Open Innovation), siguiendo el enfoque del término propuesto por Henry Chesbrough en 2003).

Para la obtención de los datos, hemos usado una metodología de estadística descriptiva. Nuestro estudio tiene como objetivo describir y explicar la diferencia entre las empresas catalanas y realidades empresariales de países de la UE en un contexto de Pymes intensidad tecnológica media o baja.

En este contexto de Pymes y sectores de intensidad tecnológica media o baja nuestra investigación muestra que el proceso de innovación en Cataluña se puede abordar en tres dimensiones : el efecto de las actividades de OI , el proceso de implementación de OI y la fuente externa de conocimiento de la OI en las empresas catalanas. El efecto de la implementación de actividades de OI dentro del proceso de innovación industrial ha mejorado significativamente los últimos años.

La investigación analiza el éxito de distintas estrategias. Investiga la relación entre las actividades de OI y las Pyme de sectores de intensidad media o baja en Cataluña y propone, algunas recomendaciones para el despliegue de políticas.

Abstract

Our work has focused on the theme of open innovation and Small and Medium Enterprises (SMEs). Specifically, we have investigated open innovation, its effects and its connection with the sectors of Low Medium Technology (LMT) firms' intensity. We discussed the Catalan case as a reference. We have analyzed both the concept and the model of OI, following the approach proposed by Henry Chesbrough (2003).

To obtain the data, we used a methodology of descriptive statistics. Our study aims to describe and explain the difference between Catalan companies and business realities of EU countries in the context of SMEs and LMT technological intensity.

In the context of SMEs and LMT firm's technological intensity, our research shows that the process of innovation in Catalonia can be approached in three dimensions: the effect of OI activities, the implementation process of OI and external source of knowledge of Catalan companies. The effect of the implementation of OI activities within the innovation process industry has improved significantly in recent years.

The research analyzes the success of various strategies. We investigate the relationship between OI activities and LMT, SMEs sectors intensity in Catalonia, and proposes some recommendations for policy development and implementation.

Chapter 1
Introduction

The objective of the research is to study the context of Small and Medium Enterprises (SMEs) and Low Medium Technology (LMT) firms and the effect of Open Innovation (OI), Research & Development activities (R&D), University Research activities (UR) and External Source of Knowledge in the industrial sector. The major purpose of our research is to investigate the importance of (OI) activities in Catalan SMEs and LMT firms. The chapters that follow cover and shed light on the explanation of the PhD research.

'OI activities' is a term promoted by (Henry Chesbrough, 2003). The aim of the research is to support the industry by developing a kind of knowledge and understanding concerning the innovation process of SMEs/ LMT firms. We analyse the effect of OI activities and their strategies in SMEs and LMT firms to describe the terms of the current situation within the field. We review the literature and present a discussion of the link between OI activities and R&D, UR activities and external sources of knowledge in the field of SMEs and LMT firms.

The research focuses on the frameworks followed by several European Union (EU) countries that we compare with the existing frameworks in Catalan firms. We analyze the relationships between SMEs/ LMT firms and OI activities that have focused on the process of innovation in several EU countries that have shown successful results and positive impact. We also examine the links between OI activities and the outcome of R&D and UR activities in these fields.

We identify the current issue and the innovation process in the fields of Catalan LMT/ SMEs firms and industries including the following issues:

The Importance of low/ medium Technology, Industries and Firms in Catalonia

We investigate in order to understand the growing demand for innovation in SMEs/ LMT firms in EU countries and Catalonia. We analyse the external sources such as the collaboration between partners and firms in EU countries and Catalonia. We also look into the collaboration in R&D and UR activities within the firms in the field. We focus on the implementation of OI activities and evaluate the implementation of OI activities in several EU countries and compare to Catalan process of implementing OI activities in their firms.

We analyse the implementation processes of OI activities in SMEs/ LMT firms and the importance of R&D and UR activities in the Catalan LMT Firms. We review the progress of the implementation process in SMEs/ LMT firms in order to examine the benefits of implementing OI activities in Catalonia. We identify the current process of OI activities in SMEs/ LMT firms as follows:

First, we identify the current planning and process of R&D and UR activities in Catalan SMEs/ LMT firms and compare it to the average level of innovation in several EU countries. We then determine the implementation process of OI and use methods and theories of the OI model to understand the implementation process and performance in SMEs/ LMT firms from different EU countries and Catalonia.

Second, we analyse the effect of the implementation process of OI activities and observe the performance of the innovation process in SMEs/ LMT firms. We also identify the current obstacles and opportunities in SMEs/ LMT firms and indicate steps for successful implementation of OI activities in Catalan SMEs/ LMT firms.

The key findings on OI activities of industries and SMEs/ LMT firms in Open-Alps and Catalonia indicate the importance of the relationship between EU countries and Catalonia in implementing OI activities. This is an opportunity for Catalan SMEs/ LMT firms to partner with other EU firms. Such external source of OI activities will encourage Catalan SMEs/ LMT firms to improve their performance in their respective fields. Communication technology enables SMEs/ LMT firms to understand the way that international and regional firms innovate and have relationships in the field with innovation activities.

The Characteristics of the Research

Our references refer to the concept of OI activities, R&D activities, UR activities, external source of knowledge and SMEs/ LMT. The purpose of the research is to understand OI activities in the field of SMEs/ LMT firms in Catalonia by discussing empirical literature provided from (H. Chesbrough, 2003). We divided the topic of the research into three dimensions: a) Industries and firms in Catalonia; b) Implementation process of open innovation activities and c) the use of external source of knowledge.

Industries and Firms in Catalonia

The literature in chapter two on Catalan SMEs and LMT firms focusses on the history of correspondence with authors such as: “Pavitts, 1984; Nelson, 1959; Arrow, 1962; Mansfield, 1981 and Link 1982, 1985” who pioneered literature about innovation pattern in the field.

In the following Chapter, we reviewed the literature and found out that R&D activities and UR activities are a key success factor for firms and OI activities encourage SMEs/ LMT firms to devote more resources towards it. We encourage LMT firms to increase spending on OI activities and other innovation activities. We suggest that further links have to be established between firms and R&D activities, UR activities in the innovation process which is still facing challenges in Catalonia. Our main questions to this chapter are:

- (1) Do LMT firms spend money on innovation activities and how do they spend it?
- (2) Does the innovation process in LMT firms include open innovation activities?

To answer our research questions, we focus on the development of different strategies that might be applied in the field of SMEs/ LMT firms. We found out that in the field of OI model, concept and activities, the authors who explain this correspondence and describe OI activities are: “Chesbrough, 2003, 2006, 2007; Chesbrough and Crowther, 2006, 2007; Dahlander, Gann, 2010; Gassmann, 2006; Vanhaverbeke, Van de Vrande and others”.

In the field of R&D activities and OI activities, authors who explain this correspondence of the literature are: “Vugelters, Cassiman, 2005; Robertson, Patel, 2007; Chesbrough and Schwartz, 2007; Koschatzky, 2004; Siegel, Waldman, Twater and LINK, 2003; Wieser, 2005; Freeman, 1994; Mohan and Mariesse, 2005; A.N. Link, D.S. Siegel, 2006”.

In the field of Catalonia, Spain and policy implications, when we started to review the literature, we found the following authors correspond to the subject such as: “Dahlander, Gann, 2010; Cooke, 2001; Fritsch and Stephan, 2005; Argote, McEvily, and Reagans, 2003; Zahra, Sapienza and Davidsson, 2006; Garrido and Duch, 2009; Freeman, 1982; Lundvall, 1992; Nelson, 1993; OECD paper, 2010; Nieto, Santamaría, 2007”.

Implementation Process of Open Innovation Activities

Literature review and focus on the research in Chapter three “The Implementation process of OI activities pattern” corresponds to the following authors: “Chesbrough and Crowther, 2006; Van de Vrande et al, 2009; Chesbrough, 2003; De Backer et al. 2008; Enkel et al. 2009; Lichtenthaler and Ernst, 2009; Lichtenthale, 2009; West and Bogers, 2010; Parida, Johansson, and Larsson, 2009; Ebersberger, Blosh, Hestad and De Velde, 2010; Chesbrough, 2003, 2009; Ellen Enkell, Oliver Gassmann and Henry Chesbrough, 2009”.

In the following Chapter, we investigate to understand the growing demand of SMEs/ LMT firms in several EU countries and Catalonia. We also look into the collaboration in R&D and UR activities within the firms in the field. We also evaluate the implementation process of OI activities in several firms in EU and compare it to Catalan process of implementing OI activities in their firms. Our main questions are:

- A. How does an open innovation tool develop solutions for LMT firms that can improve the performance through an implementation process in Catalan LMT firms?
- B. What support do LMT firms require to implement OI processes and become OI firms?

In answering our research questions, we focus on the different implementation process of OI activities that might be applied in the field of Catalan SMEs/ LMT firms. We found out that the following authors explain the implementation process of OI activities in their literature: “Chesbrough et al, 2006; Laursen and Salter, 2004, 2006; Dahlander and Gann’s, 2010; Spithoven, 2010; Rajneesh Narula, 2004; Hyukjoon and Parks, 2010; Hirsch-Kreinsen et al. 2005”.

Some authors corresponding to the literature in the field of Catalonia, Spain and innovation activities are: “Dittrich and Duysters, 2007; Chesbrough and Prencipe, 2008 and Enkel, 2010; Chesbrough et al., 2006; Jeppesen & Lakhani, 2010; Chesbrough, Vanhaverbeke, and West, 2006; Laursen and Salter, 2006; OECD, 2010; Bender et al, 2005; Tunzelmann and Acha, 2005; Arundel et al. 2008; Hirsch- Kreinsen, 2008; Saenz et al. 2009; Huang et al. 2010; Chiaroni, 2011; Santamaria, Nieto, A. Barge- Gil, 2010; Carlos Vivas, Andres Barge Gil, 2012. ; OECD, 2006; OECD, 2013; PIMEC, 2013; Segarra

& Teruel, 2011; Maribel Guerrero, David Urbano, James Cunningham, Damien Organ, 2012”.

The Use of External Source of Knowledge

The focus of literature in chapter four is on the use of external source of knowledge and OI concept in the field. Some authors who address this in their analysis are: “Cohen and Levinthal, 1990; Geletkanycz and Hambrick, 1997; Faulkner, 1994; Hall and Jones, 1999; Chesbrough, 2003, 2003b, 2006. Tsai and Wang, 2008; Saguy, 2011; Maula et. Al. 2006; Lichtenthaler and Ernst, 2007; Roper *et al.*2008; Van de Vrande et al. 2009; Saguy, 2011; Link et al. 2006; Siegel, 2004; Bender and Laestadius, 2005; Berends et al. 2005; Robertson and Patel, 2007; H. Hirsch-Kreinsen, D. Jacobson, S. Laestadius and S. Keith, 2003.; Terwiesch and Ulrich, 2009; Raymond & St-Pierre, 2010; Kirner et al., 2009; Klevorick et al., 1995; Lee et al., 2001; Grimpe & Sofka, 2009”.

In the following Chapter, we show the strength and ability in the fields of SMEs/ LMT firms and determine: “How the innovation process increases their collaboration with external sources of knowledge in the field of SMEs/ LMT firms”. We try to understand the current situation and the innovation level in the field of SMEs/ LMT firms. We observe the outcome of UR and R&D activities in Catalan ICT firms and compare it to Open-Alps platform. We analyse and compare the use of external sources, such as collaboration between partners, between firms in the Open-Alps platform and those in Catalonia. Our main questions are:

- (1) Are OI activities considered an important factor in the innovation process in Catalan LMT firms and Open-Alps?
- (2) How do Catalan and Open- Alps SMEs/ LMT firms identify useful external source of knowledge in their firms?

In answering our research questions, we focus on case studies of Catalan ICT sector and Open- Alps in SMEs/ LMT firms, industries sector, to analyse the average level of innovation in Open-Alps and Catalonia. Authors intending to contribute to literature review in this chapter are: “Hansen and Serin, 1997; Fritsch and Stephan, 2005; Glaister and Falshaw, 1999; Von Hippel, 1988; Valls et al, 2004, 2008; Segarra-Blasco, 2010; OECD, 2008, 2009, 2010; Torrent and Vilaseca, 2008; Badescu and Garcés-Ayerbe, 2009; Santamaria et al., 2009”.

Finally, we use OI activities in SMEs/ LMT firms and analyse the literature for relationship between SMEs/ LMT firms in Catalonia and Open-Alps project as a case study in order to compare their innovation processes. In the end, we analyse the innovation level of Catalan SMEs and LMT firms and evaluate them by focusing on OI activities and the needs of innovation process in the SMEs and LMT firms.

CHAPTER 2

The Effect of Research & Development, Activities and Open Innovation Activities a Key To: Low/ Medium Technology Industries and Firms in Catalonia¹

ABSTRACT

Research and Development (R&D) activities and Open Innovation activities (OI) have been of crucial importance in Low/Medium Technology (LMT) sectors that are based on the innovation abilities of LMT firms. This chapter analyses the links between OI activities and R&D activities in Catalan LMT firms. First, we develop a model of how innovation is developed within LMT Catalan firms. By analysing R&D and OI activities in LMT firms, we measure both internal and external activities of these firms. Secondly, we explore the effects of R&D activities and OI activities in the industrial sector, and then the effects of both in the market of the Catalonia region. Catalan LMT firms have unique opportunities in the innovation process, yet face some obstacles. The objective of this article is to advocate for bridges to be built between university research and public centres, and LMT firms in Catalonia. To define the current issue within the field of Catalan LMT firms, we sample 2008 to 2010 data from the Spanish National Statistical Institute (INE), Statistical Institute of Catalonia (IDESCAT), and the Organization for Economic, Cooperation and Development (OECD).

¹ This chapter was published in December 2013 at the International Journal of Innovation Science. El Rayyes, A.; Valls-Pasola. J. : The Effect of Research & Development Activities and Open Innovation Activities: A Key to Low/ Medium Technology Industries and Firms in Catalonia. *International Journal of Innovation Science*, 2013, 225- 236.

Introduction

Low/Medium technology is a key focus of technological innovation in Catalan firms. This first essay examines LMT innovation technology literature and focuses on the innovation process, with special emphasis on the effect of both R&D activities and OI activities on Catalan firms. Empirical evidence shows that cooperation with universities and public research centres complements other innovation activities and cooperation with other partners.¹ Regarding R&D activities; Spanish LMTs have a long track record of improvement and demonstrate above average technological performance.²

Previous studies have shown that firms can improve their position in different stages and aspects. For example, R&D activities and open innovation that use partners can create business models to reduce R&D expenses expand innovation output and open up new markets. If objectives are clear, R&D capabilities are known and business models are aligned.³ Firms are aware that only a small proportion of innovative people are employed in house, and that a lot of unique knowledge and ability lie outside the firm's boundaries and internal R&D department.⁴ Today, both R&D activities and open innovation depend on innovation technology in the fields of low tech, medium tech and high tech. For external R&D activities, outside consultants are called upon to improve the abilities of firms to perform R&D activities and to interact with other agents.^{5,6,7} Open innovation is reviewed deeply in this article, with special attention paid to the effect OI has on internal and external ideas in LMT firms. The key to the effective application of OI is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to the market, as firms look to advance their technology.⁸ Also, purposive inflows and outflows of knowledge accelerate internal innovation and expand the market for external use of innovation, respectively.⁹

As we define our research hypothesis, we recognize that local needs warrant investigation of LMT, asking how R&D activities and their capacity for innovation are affected by the use of OI in the external and internal activities for LMT firms. It is important to understand this relationship, since the main aim of economics is to evaluate whether the return on this investment justifies the expenditure, and to offer a guide to managers and policy makers on how to choose their investments and evaluate the success of various strategies.¹⁰ The purpose of this article is to examine our Conceptual Model and Hypotheses. We propose an explanation for R&D activities

and OI activities in LMT firms, with a focus on the effect of both R&D activities and OI activities on Catalan firms.

Open innovation requires knowledge drawn from beyond LMT firms' boundaries. Even the most innovative organizations cannot rely solely on internal sources, but also require knowledge from beyond their boundaries.^{11,12} OI has grown in popularity for at least three reasons:¹³ (1) changes to work patterns where professionals are seeking portfolio careers rather than singular jobs-for-life, and work contexts that involve increasing divisions of labour; (2) improved market institutions such as property rights, venture capital, and standards are enabling increased trade knowledge; and (3) new technologies are easing coordination across geographical distance. An LMT firm in the industrial sector is able to start proactively using its knowledge.¹⁴ Firms can open up their innovation process on two dimensions: inbound and outbound.^{15,16} It is important to note, however, that as a consequence of government incentives to encourage R&D, spending has increased in R&D activities in Catalonia firms, with positive effects for LMT firms that pursue them.

2.1. Literature Review

During the 1980s, some authors pointed out that low technology industries correspond largely to Pavitt's assumption that LMT industries are composed mostly of supplier dominated firms.¹⁷ The literature on the economics of innovation considers R&D the main source of innovation.^{18,19} Open innovation is usually treated the same as closed innovation ideas, and then the firm will develop, build, market, distribute, service, finance and support them on their own.⁸ Within LMT firms, we discuss the links that exist between R&D activities and other innovation activities in LMT Catalan firms, including open innovation.

Literature attributes the successful innovation from OI and R&D, which quantitatively demonstrates that LMT, R&D and OI spending and patents have grown considerably. Knowledge, therefore, is increasingly providing evidence that LMT firms should adapt to this new situation. Knowledge from research institutions is generally more distant from the application stage.^{20, 21} Several factors have contributed to the popularity and importance of OI.^{22,23} Reviews of literature about firms that innovate using both OI and R&D activities, in the meantime,¹¹ also seek the study of open

innovation practices in traditional industries. In this sense, internal R&D knowledge sources and external knowledge sources must rely on collaboration among the partnering organizations. Even the largest and most active innovative organizations can't rely solely on internal sourcing; they also require knowledge from beyond their boundaries.^{11,24} This view fits the so-called open innovation model.⁸

Empirical evidence of OI in LMT firms has been found in the field of innovation. The open innovation approach^{25,26} results in stable or increased R&D spending in organizations where open innovation was adopted.¹¹ In addition to a search for information from different sources, co-development of innovation has also proved important.²⁷ In this sense, it is understood that the innovation process of Catalonian LMT firms needs to link between R&D and open innovation activities.²⁸ In terms of traditional quantitative indicators, Catalonia's performance over the last decade looks quite impressive. Additionally, there is a large and growing body of literature that focuses on the relevance of the notion of regional innovation systems, not only as an analytic tool to better understand the spatially determined drivers of innovation, but also as a policy concept.^{29,30} This position is strongly advocated in the literature on the [Spanish] national innovation system.^{31,32,33}

From a theoretical point of view, the article refers to results of both R&D activities and OI in LMT Catalan firms. Access to sources of finance for R&D activities is very important, directly influencing implementation of LMTs' R&D activities in two ways: (1) the selected sources of finance mitigates liquidity constraints, which are frequently an obstacle to LMT innovation, and (2) the selected source of finance influences the outcome of innovation, given that it promotes or discourages acceptance of the risk associated with R&D activities.³⁴ Open innovation includes both internal and external ideas and paths to the market to increase the importance of OI as well as R&D activities in Catalan LMT firms.

The effects of LMT firms on industries in Catalonia are an integral part of advanced industrial regions³⁵ in the debate on low-tech innovations.³⁶ Indeed, recent studies show a dynamic and integrative view may deepen our understanding of knowledge strategies, their modification over time, and their effects on innovation performance.^{37,38}

Catalan LMT firms considered in this article engage in both R&D and OI activities. While results are often successful in other firms when OI is implemented, we examine LMT firms in Catalonia industries that benefit from OI activities. According to the OECD, improvement in Catalan knowledge exploitation and technology transfer sub-systems have proven more difficult to achieve than in its knowledge generation sub-system. While these firms are responsible for approximately two-thirds of R&D, Catalonia's technology transfer system can be characterised as public-driven, since the infrastructure for technology transfer is mainly publicly funded and relatively recent. A number of institutions have developed with public support, including those with the labels of Technology Centres and Technology Dissemination Centres launched in 2004.³⁹

Linking R&D activities with OI activities in LMT firms depends on the amount of government expenditures for R&D activities compared to spending on all other innovation activities in Catalonia as a way to determine priorities. In the meantime, we ask:

- (1) Do LMT firms spend money on innovation activities and how do they spend it?
- (2) Does the innovation process in LMT firms include open innovation activities?

In this article we will define LMT firms, innovation activities, and the obstacles among both R&D activities and OI activities.

2.2. Conceptual Model and Hypotheses Formulation

Our review of the relevant literature on the topic helped us to write hypotheses to explain LMT firms in Catalonia, which focuses on factors relevant to the fields of study. Additionally, the model explains R&D activities as well as OI activities. To identify any relation to open innovation, the following points are selected to identify solutions to the research issues. Several studies suggest that technological innovation relies heavily on knowledge from universities and research institutions.^{40,41,42,43} The concept of open innovation explicitly considers the trend toward inter-organizational innovation processes.⁴⁴ After reviewing the literature on Catalan LMT firms, we suggest the following.

2.2.1. Hypotheses

H.1 R&D activities and LMT firms: The difference of innovation activities in Catalan firms depends on R&D activities that positively affect LMT.

H.2 OI activities and LMT firms: Companies behave differently with external and internal ideas. As they cannot rely entirely on their own research, they license patents from other companies.

H.3 Catalan market, new products, and LMT firms: Market research provides information about demand for a product. Sale of a new product in the market positively affects LMT firms that operate with R&D activities.

2.2.2. The Model

Our process was used to define and analyse LMT industrial firms in Catalonia. Requirements needed to support the LMT firms' innovation processes. We use existing literature and data to support our model of what is required to support an LMT firm's innovation process. There is evidence from both the literature and data to suggest that the model of Catalan firms is relevant to specific points: LMT firms, Catalan industries, R&D activities and OI activities. Traditionally, industrial firms developed new technologies for their own products internally;^{45,46,47,48} and OI activities, that is, the use of purposive inflows and outflows of knowledge, can accelerate internal innovation and expand the markets for external use of innovation, respectively.⁴⁹ Taking this into account, hypothesis formulation will test an explanation for LMT innovation in Catalan firms. We focus on R&D innovative activities and OI innovative activities. The relationship between open innovation and LMT firms is to understand innovation processes through innovation literature. The conceptual model is as follows:

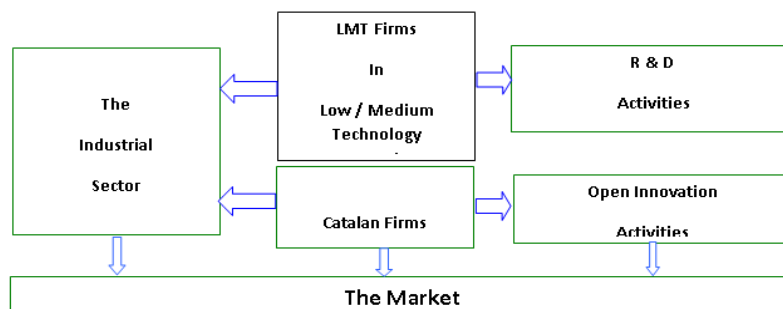


Figure 1: Conceptual Model

2.2.3. Main Characteristics of LMT Firms' Industrial Sector in Catalonia

H.1 R&D activities and LMT firms: The difference of innovation activities in Catalan firms depends upon R&D activities that positively affect LMT.

Catalonia presents a unique blend of R&D and innovation technologies in basic and applied research to R&D development. Firms with low levels of productivity may achieve a higher return because they adopt more risky R&D strategies.^{50,51}

H.2 OI activities and LMT firms: Companies behave differently with external and internal ideas. As they cannot rely entirely on their own research, they license patents from other companies.

In many countries, OI is recognized as a critical ingredient for corporate competitive success. Most companies face the challenge of implementing OI in their companies. In Catalonia, all sources of innovation, such as R&D activities, OI and both internal and external activities are considered in order for Catalan companies to be competitive with the industrial world. In addition to R&D and OI firms, recent studies indicate that firms have an open attitude towards external knowledge, which has been shown to be especially important for the innovation process in LMT industries.⁵² University entrepreneurship programmes should therefore also support existing industries and LMTs.⁵³

H.3 Catalan market, new products, and LMT firms: Market research provides information about demand for a product. Sale of a new product in the market positively affects an LMT firm that operates with R&D activities.

The aim of OI is to give Catalan companies stronger positions in the early stage of market development into innovative ideas and marketable products through innovative technologies, which many companies in Catalonia integrate into their marketing strategy. An OI market place offers a space for collaboration for Catalan companies to create opportunities for discovering potential ideas and to choose companies able to solve critical issues through R&D activities and OI activities. This type of measure represents firms' absorptive capacity more accurately than the R&D intensity measure (R&D expenditure/sales) widely used in prior research.^{54,55,56,57,42} Product and market orientation is higher than in larger research departments of large firms. This creates a bias to action in smaller firms and promotes extensive experimentation with alternative business models. In many innovative situations,

identifying and executing an effective business model is as important as or more important than developing a new technology. Catalan firms should have the ability to catch up using the innovation processes and new technology.

For innovation activities in the industrial sector, the analysis focused on innovation activities in LMT firms in Catalonia. R&D activities and OI activities are the main focus of this article. In the meantime, we explain the current innovation processes in LMT Catalan firms. To find out the strengths and weaknesses of LMT firms in Catalonia, we discuss how LMT firms spend money on innovation activities, such as open innovation and others.

According to OECD reports,⁵⁸ the crisis of 1984, the entry of Spain into the European Union (EU), and the 1992 Olympic Games, among other factors, facilitated a progressive transition of the Catalan economy to a new economic development model. Catalonia has been characterized by a large manufacturing base: 26 percent of the regional gross value added (GVA) in 2000, 20 percent of regional GVA, and 20.8 percent of employment in 2006. This is higher than Spain's 15 percent and the EU15's 17.9 percent. Note that different data sources report either a stable or declining absolute number of manufacturing jobs. If you add both manufacturing and market-related production services, these sectors account for 53.7 percent of employment and 59.4 percent of GVA. Catalonia's manufacturing is more technology-intensive than the rest of Spain, but about average for OECD regions generally.

The predominance of small and medium-sized enterprises (SMEs) in different areas of specialization has contributed to the development of a number of such local production systems. Forty-two have been identified across the metropolitan area of Barcelona and the rest of Catalonia. SMEs represent 93.2 percent of GVA in the primary sector, 91.8 percent in construction, 66.2 percent in services, and 56.2 percent in industry. Large firms continue to register a significantly higher average GVA per worker than SMEs, which are at 75 percent of that of large firms. Yet it is small firm productivity per worker that has grown more over the last few years, while that of medium and large-sized firms has decreased. Catalonia has many international linkages, being one of the main Spanish regions for foreign direct investment (FDI) inflows and outflows, along with growing exports and the presence of many foreign firms. The region's trade-to-GDP ratio grew from 24.7 percent to 32.5 percent between 1995 and 2005.

According to Government of Catalonia reports,⁵⁹ the value-add per unit sold by Catalan SMEs decreased significantly in 2010 compared to 2009 and stood at 28.0 percent. Thus the income generated by sales, measured in terms of billing in Euros, decreased from 28.4 percent in 2009 to 28.0 percent in 2010. However, this value is the second largest in the series since 2006. In 2010, the decline has also been accompanied by a decrease in the weight of other operating expenses (-0.6 percentage points) and with an increase in the weight of operating consumption (1.0 percentage point). From 2006 to 2010, the trend observed is the increase of GVA, except for a moderate turning in 2010 of the other operating expenses and a decrease of operations consumption, with the exception of the last year's report (in 2010).

From a dynamic perspective, relating to the biennium 2009-2010 in all categories of companies, the weight of operating expenses increased. Micro-enterprises are the ones that evolved more negatively with respect to the weight of operating expenses per unit of income (+1.6 points percentage between 2009 and 2010), which has led to a reduction in the added value obtained by the unit of operating income (-1.3 percentage points) and a more moderate weight in other operating expenses (-0.3 percentage points). This trend was similar, but to a lesser extent, in small sized companies where added value per unit sold decreased (1.0 percentage points) as a result of an increase of 1.3 percentage points in the weight of operation expenses and the reduction of 0.3 percentage points in other operating expenses. Finally, in the company average, the rest of operating expenses have declined (1.0 percentage points), which has resulted in a weighted gain of 0.6 points GVA; the rest of operating costs consume 0.4 percentage points (see Fig. 2).

Figure 2 Basic structure of the income of Catalan SMEs, 2006-2010,

100%	25,9	26,4	26,9	28,4	28
80%					
60%	15,6	15,7	16,9	18,2	17,6
40%					
20%	58,5	58,0	56,2	53,4	54,4
0%	2006	2007	2008	2009	2010

Source: Government of Catalonia. Annual of Catalan SMEs, Economic and -Financial Result: 2006-2010⁵⁹

2.3. Evidence from LMT Catalan Firms

The data cited in this chapter are used to describe the content and the unit of measurement for LMT firms in Catalonia. Our data indicating a focus on the years 2008 to 2010 is derived from several sources: The Spanish National Statistical Institute (INE), Statistical Institute of Catalonia (IDESCAT), and Organization for Economic Co-operation and Development (OECD). We use a type of descriptive statistic as an indicator for LMT firms, technological innovation and industry in Catalonia. It is important to consider that, according to OECD classification; Catalan LMT firms are relatively small in size, having fewer than 250 employees.

2.3.1. Descriptive Statistics

The descriptive statistics is a set of measurements that define an overview of LMT Catalan firms. The variable introduced by the Spanish National Statistical Institute (INE), the data was for all Spain, and Statistical Institute of Catalonia (IDESCAT), are extrapolated for Catalonia region only. Tables 2, 3, and 4 explain R&D activities for Catalan LMT firms, industries sector. Results in Table 5 explain OI activities for LMT firms and how the innovation process could be implemented in Catalonia.

Table 1. R&D activities in Catalan firms, 2010

	Value % of GDP		
	2008	2009	2010
Catalonia	1.61	1.70	1.65
Spain	1.35	1.39	1.39
Eurozone	:	:	:
European Union	1.92 (s)	2.02 (s)	2.01 (s)
Catalonia	1.61	1.70	1.65

Source found on line at IDESCAT, www.idescat.cat⁶⁰

Table 2 Technological Innovation Companies in Catalonia, 2010

	Value		
	2008	2009	2010
Companies with innovative activities	8184	7045	5334
Companies spending ¹			
R + D internal	3383	2853	1969
R + D external	1751	1352	1106
Acquisition of machinery and equipment	3763	3718	2770
Acquisition of other external knowledge	325	267	121
Training	1204	824	2164
Marketing	2391	1640	1251
Design, other preparations for production or distribution	845	803	463
Innovative companies in the given period ²	9180	8599	6918
Total firms of percent	23,7	23,6	21
By type of innovation ¹			
Product	4262	4172	3382
Process	7673	7297	5718
Product and process	2755	2870	2181
Innovative Companies ³	10429	9506	7441
Total of Innovative companies %	26,9	26,1	22,6
Companies that have cooperated in innovation ³	1683	1674	1378
Innovative companies for patents ³	624	533	485

Source Found on line at IDESCAT, www.idescat.cat December, 12, 2012. Next period, 2011: July 2013⁶¹

Result: Table 2.

In 2011, 5334 companies in Catalonia engaged in activities that can be considered innovation activities. Of these companies, 36.9 percent allocated resources to Internal R&D spending, and 20.7 percent spent from their innovation budget on external R&D activities. It's important to note that of companies engaged in innovative activities, 51.9 percent purchased machinery and equipment, 40.6 percent spent on training, and 23.5 percent spent on marketing. In the previous three years, the number of innovative companies was 6918, representing 21 percent of total Catalan enterprises. Depending on the type of innovation, there is a greater tendency for process innovation, followed by product innovation. The number of innovative companies, stood at 7441, representing 22.6 percent of the total business. In Spain, the number of

companies with innovation activities was 24, 645 and the number of Innovative companies stood at 35,226.

Table 3. Technological Content Exports, by product.

	Change per year in Million Euros			
	value	absolute	%quarter	%accumulated
All Exports of industrial products	14184,2	1121,5	8,6	4,5
High-technology	1374	63,3	4,8	3,1
Pharmaceutical products	975,6	127,8	15,1	8,4
Computer products, electronics and Optics	384,7	-71,9	-15,7	9,3
Other	13,6	7,4	119,4	31,8
Medium/ high tech	6956,4	771,3	12,5	6,1
Chemical products	2375,1	115,9	5,1	3,5
Electrical equipment, machinery and Vehicles	4353,2	607,6	16,2	7,9
Other	228,1	47,9	26,6	4,2
Medium/ Low -tech				
Rubber materials, plastic products, minerals	2145,6	-260,8	-10,8	-6
Metal and metallurgy	1204,3	5,8	0,5	2,9
Metal products	360,7	-9,7	-2,6	-3,1
Other	580,5	-256,9	-30,7	-28,6
Low-tech	3708,2	547,7	17,3	8,5
Food , product, Textiles, Leather and foot wear Wood and paper	3418,7	557,5	19,5	9
Other	289,5	-9,8	-3,3	2,1

Source Found on line at IDESCAT, www.idescat.cat year fourth quarter, 2012, quarter, 2013. June 10, 2013⁶²

Result: Table 3.

In the fourth quarter of 2012, Catalonia exported industrial products worth 14,184.2 million Euros; high technology exports saw an increase of 4.8 per cent, despite a 15.7 per cent decrease in sales of computer, electronics, and optics. Also up compared to a

year ago, exports of low tech industries rose by 17.3 per cent. As for Spain as a whole, sales of industrial products abroad increased by 2.6 per cent compared to the same period a year ago.

Table 4. Technological Content Imports, by product.

	Change per year in Million Euros			
	Value	absolute	% quarter	% accumulated
All Imports of industrial products	14103,8	-778,8	-5,2	-5,9
High-technology	1883,3	-183,9	-8,9	-7,8
Pharmaceuticals product	811,1	-32,5	-3,9	1,9
Computer products, electronics and optics	1071	-147,9	-12,1	-14,7
Other	1,3	-3,5	-73,8	-60
Medium –tech high	6345,8	-237,3	-3,6	-5
Chemicals product	2462,4	117,7	5	-0,7
Electrical equipment, machinery and vehicles	3584,8	-325	-8,3	-7,4
Other	298,6	-30,1	-9,1	-10,4
Medium-tech Low				
Rubber mat, plastic products, minerals	2301,9	-249,6	-9,8	-9,7
Metal and metallurgy	1062,1	-127,4	-10,7	-9,1
Metal products	349,6	-32,1	-8,4	-10
Other	890,2	-90,1	-9,2	-10,1
Low-tech	3572,7	-107,9	-2,9	-3,4
Products, food, textiles, leather and footwear, wood and paper	3174,7	-96	-2,9	-3
Other	398	-11,9	-2,9	-6,3

Source Found on line at, IDESCAT, www.idescat.cat, period, March 11, 2012. 1 quarter, 2013,. June 10, 2013⁶³

Result: Table 4.

Catalonia has imported industrial products worth 14,103.8 million Euros. The fourth quarter of 2012 represents a decrease of 5.2 percent, compared to the fourth quarter in 2011. In the category of high tech, imports fell 8.9 percent, due mainly to a 12.1 percent decrease in purchases of computers, electronics, and optics. The high average level decreased by 3.6 percent, but within this group we find a 5 percent increase in chemical imports. Decreases were also seen at medium-low and low levels, 9.8 percent and 2.9 percent, respectively. In comparison, purchases of all Spanish industrial products fell by 11.3 percent compared with the same period a year ago.

Table 5. Technology Transfer Activities of Catalan Universities 2008

University	Faculty	Technician	R&D Contracts (1000s)	Services Thousands of Euros	National Patents	PCT Extensions	Licences (EUR K)	Spin -off
UAB	2 836	26.0	14200.0	4 745	26	9.0	100.0	5
UDL	589	9.0	2 276.2	452	2	3.0	2.5	1
UDG	838	15.0	3 531	610	3	0.0	2.0	0
UPC	1 889	29.0	39863.0	3 473	35	12.0	133.0	9
UPF	470	11.0	6 475.0	0	4	2.0	165.9	1
URL	567	28.5	7 816.0	750	6	2.0	0.0	1
UB	3 758	22.0	15621.0	1 816	20	11.01	118.0	0
URV	249	17	6 701.9	901	8	1.0	0.0	2
Total	11 196	157.5	96484.1	12 747	104.0	40.0	521.4	19.0

Source, OECD, The autonomous region of Catalonia, Spain, 2010⁶⁴

Result: Table 5.

According to OECD reports, an important contribution to Catalonia's innovation system is the development of any innovation system that promotes open innovation through multicentre business parks with services to support the entire innovation process in Catalonia.

2.3.2. Main Results

At this point we should note that statistical results support our three hypotheses:

H.1 Only 36.9 percent of all companies allocated resources to internal R&D spending, and only 20.7 percent of all companies allocated resources from their innovation budget to external R&D activities.

As Table 2 shows, companies in Catalonia need to spend more on R&D activities to improve and develop the innovation process for the region's industrial sector.

H.2 We also found that low tech industrial product exports increased by 17.3 percent, but industrial product imports decreases? At medium and low levels (9.8 percent and 2.9 percent, respectively).

As shown in Tables 3 and 4. We discussed the importance of technology transfer to support the innovation process and industrial sector in Catalonia.

H.3 Open innovation activities and university research will help the innovation process in the industrial sector and greater spending on innovation activities will increase the number of companies engaging in internal R&D activities. In the meantime, it will increase the number of companies that devote resources from their innovation budgets to external R&D activities.

According to Figure 2, Catalan SMEs decreased significantly in 2010, indicating a need for existing ones to spend more on R&D activities and a need for a bridge between LMT firms and universities. Spanish firms, especially in a context of low medium low tech (LMT) sector where most of the firms are SMEs.⁶⁵

2.4. Concluding Remarks

In this paper, we described the innovation process in Catalan firms. We created a model that explains the size of companies, their R&D activities, and OI in Catalan LMT firms. Our article analyses the relationship between innovation process and performance, and R&D activities. Process in Catalonia shows impressive improvement at different levels, but the performance of LMT firms in Catalonia in their innovation processes still faces challenges. Though R&D activities have positively affected Catalan LMT firms, there are still challenges in the innovation process in LMT firms. While 20.7 percent of firms spent money on external R&D, 51.9 percent decided to spend money on the purchase of machinery and equipment, 40.6 percent on training and education, and 23.5 percent on marketing. This differential indicates that Catalan firms do not exploit possibilities for innovation as much as they might, despite positive reference to them.

Open innovation will encourage LMT firms to devote more resources toward it. Encouraging technology LMT firms to increase spending on OI compared to what they currently spend on education and marketing will increase innovation processes in

Catalonia and open firms to both internal and external activities. We suggest that further links be established and expanded between firms and university research. Still facing challenges in Catalonia are the coordination and implementation of OI in LMT firms in Catalonia and the development of different strategies that might be applied.

While LMT firms face difficult challenges in an increasingly high tech environment, LMT firms in Catalonia have several opportunities based on R&D activities and their development of innovative processes that can positively affect their position in the marketplace. These opportunities must be considered and embraced with other innovation processes and activities to solidify the future of innovation in Catalonia.

2.5. References (Chapter 2)

- [1] R. Veugelers, B. Cassiman: R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing. *International Journal of Industrial Organization*, 2005, 23, 355-379.
- [2] P.L. Robertson, P.R. Patel: New wine in old bottles: technological diffusion in developed economies. *Research Policy*, 2007, 36, 708–721.
- [3] H. Chesbrough and K. Schwartz: Innovating business models with co-development partnerships. *Research-Technology Management*, 2007, 50, 55-9.
- [4] H. Chesbrough: Open innovation. *Harvard University Press. Cambridge, MA*, 2003.
- [5] K. Koschatzky: The role of R&D services in managing regional knowledge generation-a regional differentiation, in: Karlsson, C., Flensburg, P., Hörte, S.A. (Eds.), Knowledge spillovers and knowledge management. *Cheltenham: Edward Elgar*, 2004, 254-297.
- [6] D. Siegel, D. Waldman, L. Twater and A. LINK: Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. *Journal of High Technology Management Research*, 2003, 14, 111-133.
- [7] Van Helleputte and Reid: Tackling the paradox: can attaining global research excellence can be compatible with local technology development? *R&D Management*, 2004, 34, 33-44.
- [8] H. Chesbrough: Open Innovation: The new imperative for creating and profiting from technology. *Harvard Business School Press, Boston, MA*, 2003.
- [9] H. Chesbrough: Open Business models: How to thrive in a new innovation landscape. *Harvard Business School Press, Boston, MA*, 2006.
- [10] R. Wieser: Research and development, productivity, and spillovers: Empirical evidence at the firm level. *Journal of Economic Surveys*, 2005, 19, 587-621.
- [11] H. Chesbrough and A.K. Crowther: Beyond high tech: early adapters of open innovation in other industries. *R&D Management*, 2006, 36:299-236.
- [12] P.Sanchez and J.E Ricart: Business model innovation and sources of value creation in low income markets. *European Management Review*, 2010, 7:138-154.
- [13] L. Dahlander, D.M. Gann: How open is innovation? *Research Policy*. In press, 2010, 39, 699-709.

- [14] H. Chesbrough, K. Lim and Y. Ruan: Open innovation and patterns of R&D competition. *Working Paper*, 2007.
- [15] U. Lichterthaler: Externally commercializing technology assets: an examination of different process stage. *Journal of Business Venturing*, 2008, 23, 317-30.
- [16] J. West and M. Bogers: Contrasting innovation creation and commercialization within open, user and cumulative innovation. *Working Paper, San Jose State University, San Jose CA*, 2008.
- [17] K. Pavitt: Sectoral patterns of technical change: Towards a taxonomy and a theory. *Research Policy*, 1984, 13, 343/373.
- [18] C. Freeman: The economics of technological change. *Cambridge Journal of Economics*, 1994, 18, 463- 514.
- [19] P. Mohnen and J. Mairesse: Using innovation surveys for econometric analysis, in Hall, B.H, Rosenberg, N. Eds. *Handbook of The Economic of Innovation*, 2005.
- [20] A.N. Link, D.S. Siegel, B. Bozeman: An empirical analysis of the propensity of academics to engage in informal university technology transfer, *available at SSRN: <http://ssrn.com/abstract=902207>, 2006*
- [21] D.S. Siegel: Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: quality evidence from commercialization of university technologies. *Journal of Engineering and technology Management*, 2004, 21, 115-142.
- [22] H. Chesbrough, M. Appleyard: Open innovation and strategy. *California Management Review*, 2007, 50, 57-76.
- [23] L. Dahlander, D.M. Gann: How open is innovation. *Research Policy*, 2010, 39, 699-709.
- [24] D. Rigby and C. Zook: Open market innovation. *Harvard Business Review*, 2002, 80-89.
- [25] H. Chesbrough: Open innovation: A new paradigm for understanding industrial innovation, in H. Chesbrough, W. Van haverbeke and J. West: Open innovation: Researching a new paradigm. *Oxford University Press*, 2006.
- [26] O. Gassmann: Opening up the innovation process: Towards an agenda. *R&D Management*, 2006, 36, 223-6.
- [27] H. Chesbrough and K.Schwartz: Innovating business models with Co-development partnerships. *Research Technology Management*, 2007, 50, 55-9.

- [28] A. Garrido and N Duch: Memoria Economía de Catalunya 2008, Cambra Oficial De Comerç, *Industria I Navegación de Barcelona, Barcelona*, 2009.
- [29] PH. Cooke: Regional Innovation System, Clusters and the Knowledge Economy, Industrial and Corporate Change. *Oxford University Press*, 2001, 10.
- [30] M. Fritsch and A. Stephan: Regionalization of Innovation Policy- Introduction to the Special Issue. *Research Policy*, 2005, 34, 1123-1127.
- [31] C. Freeman: The Economics of Industrial Innovation, *Second ed. Frances Pinter, London*, 1982.
- [32] B.A. Lundvall: Introduction to national systems of innovation, in: Lundvall, B.A. (Ed.). *National Systems of Innovation. Pinter, London*, 1992, 1–22.
- [33] R.R. Nelson: National Systems of Innovation: A Comparative Study. *Oxford University Press, Oxford*, 1993.
- [34] S. Smith: Beg, borrow, and deal? Entrepreneurship and financing in new firm innovation. SSRN, Working Paper, Available at: [HTTP://SSRN.COM/abstract=1573685](http://SSRN.COM/abstract=1573685), 2010.
- [35] P.L. Robertson, P.R. Patel: New wine in old bottles: technological diffusion in developed economies. *Research Policy*, 2007, 36 (5), 708–721.
- [36] H. Kreinsen, D. Jacobson, S. Laestadius, (Eds.): Low-Tech Innovation in the Knowledge Economy. *Peter Lang, Frankfurt*, 2005a, 11–30.
- [37] L. Argote, B. McEvily, and R. Reagans: Managing knowledge in organizations: an integrative framework and review of emerging themes. *Management Science*, 2003, 49, 571–82.
- [38] S.A. Zahra, H.J. Sapienza and P. Davidsson: Entrepreneurship and dynamic capabilities: a review, model and research agenda. *Journal of Management Studies*, 2006, 43, 917–55.
- [39] OECD, reviews of regional innovation, Catalonia, Spain, OECD paper, 2010, 1995- 6585 online.
- [40] B. Bozeman: Technology transfer and public policy: a review of research and theory. *Research Policy*, 2000, 29, 627–655.
- [41] G.S. McMillan, F. Narin, D.L. Deeds: An analysis of the critical role of public science in innovation: the case of biotechnology. *Research Policy*, 2000, 29, 1–8.

- [42] M.J. Nieto, L. Santamaría: The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, 2007, 27, 367–377.
- [43] O. Vuola, A.P. Hameri: Mutually benefiting joint innovation process between industry and big-science. *Technovation*, 2006, 26, 3–12.
- [44] W. Vanhaverbeke, V. Van de Vrande and H. Chesbrough: Understanding the advantages of open innovation practices in corporate venturing in terms of real options. *Creativity and Innovation Management*, 2008, 17,4.
- [45] D. Ahlstrom: Innovation and growth: How business contributes to society. *Academy of Management Perspectives*, 2010, 24, 11, 24.
- [46] J.G. March: Exploration and exploitation in organizational learning. *Organization Science*, 1991, 2, 71-87.
- [47] D.C. Wyld: Speaking up for customers: Can sales professionals spark product innovation? *Academy of Management Perspectives*, 2010, 24, 80-82.
- [48] D.C. Wyld: and R. Maurin: keys to innovation: the right measures and the right culture? *Academy of Management Perspective*, 2010, 24, 62-77.
- [49] H. Chesbrough, W. Vanhaverbeke, J. West: Open Innovation: Researching a New Paradigm. *Oxford University Press, London*, 2006.
- [50] L.M.B. Cabral: R&D Competition when firms choose variance. *Journal of Economics and Management Strategy*, 2003, 12, 139-150.
- [51] A. Anderson and L.M.B. Cabral: Go for brake or play it safe? Dynamic Competition with choice of variance. *The Rand Journal of Economics*, 2007, 38, 593-609.
- [52] K.H. Tsai and J.C. Wang: External technology sourcing and innovation performance in LMT sectors: An analysis based on the Taiwanese Technological Innovation Survey. *Research Policy*, 2009, 38, 518-526.
- [53] S. Christopherson: Technology transfer models improving the potential for business establishment and job creation, presentation at OECD round table on higher education in regional and city development, 2010, Paris OECD. Also at: www.oecd.org/document/3910,3343,en_2649_35961291_45073703_1_1_1_1,00.htm
- [54] P. Jones: Are educated workers really more productive? *Journal of Development Economics*, 2001, 64 (1), 57–79.

- [55] R. Belderbos, M. Carree, B. Lokshin: Co-operative R&D and firm performance. *Research Policy*, 2004, 33, 1477–1492.
- [56] D. Faems, B. Van Looy, K. Debackere: Inter organizational collaboration and innovation: toward a portfolio approach. *Journal of Product Innovation Management*, 2005, 22, 238–250.
- [57] W. Schoenmakers, G. Duysters: Learning in strategic technology alliances. *Technology Analysis & Strategic Management*, 2006, 18, 245–264.
- [58] OECD. Organization for Economic, Co-operation and Development, review of regional Innovation, Assessment and Recommendations, Catalonia, Spain, OECD paper, 2010.
- [59] Government of Catalonia, Annual of Catalan SMEs, Economic and Financial Result, Source found on line at:

<http://web.pimec.org/repositori/documents/actualitat/es/AnuariPimeCatalana2012.pdf>.
- [60] IDESCAT, Source found on line at: www.idescat.cat, Link,
<http://www.idescat.cat/economia/inec?tc=3&id=8301&lang=en>.
- [61] IDESCAT, Source found on line at: www.idescat.cat, December, 12, 2012. Next period, 2011: June 2013, Link,
<http://www.idescat.cat/economia/inec?tc=3&id=6111&lang=en>
- [62] IDESCAT, Source found on line at: www.idescat.cat, period, March 11, 2013. 1 quarter, 2013, June 10, 2013. Link,
<http://www.idescat.cat/economia/inec?tc=3&id=0814&lang=en&dt=201204&x=8&y=9>
- [63] IDESCAT, Source found on line at: www.idescat.cat, period, March 11, 2013. 1 quarter, 2013, June 10, 2013. Link,
<http://www.idescat.cat/economia/inec?tc=3&id=0815&lang=en&dt=201204&x=9&y=15>
- [64] OECD, Organization for Economic, Co-operation and Development Source found on line at: <http://www.oecd.org/edu/imhe/46826969.pdf>.
- [65] F. D. B. Trujillo-Ruiz, J.L. Hervas-Oliver, Internal and relational knowledge and absorptive capacity in SMEs: Understanding firms' innovation performance through R&D and Non R&D activities, *DRUID Paper*, 2001, M00, L20, C10.

Chapter 3

Research and Development, University Research and Open Innovation: Towards an Implementation Process within Catalan Low and Medium Technology Firms

ABSTRACT

This chapter analyses the implementation processes of Open Innovation (OI), Research and Development (R&D) and university research (UR) activities in the Catalan, Low/Medium Technology, and (LMT) firms. We review the R&D and UR activities progress and OI implementation process in LMT firms in order to examine the benefits of applying an implementation process for innovation in the industrial sector of Catalonia. We define the current process of OI activities in LMT firms' fields. First, we identify the current planning and process of R&D and UR activities in Catalan LMT firms, and we determine planning the implementation process of OI. We use methods and theories of the OI Model to develop the implementation process and performance in LMT firms. Second, we analyse the effect of the implementation process of OI and observe the performance of the process in LMT firms. We also identify the current obstacles and opportunities in LMT firms and indicate steps for successful performances of Catalan LMT firms. Our framework for implementing OI process as a concept aims to understand the current situation and its obstacles and opportunities for LMT firms.

Introduction

The aim of this chapter is to ascertain the progress of innovation, to explain the access to the context of OI model, in the field of LMT firms and Small and Medium Enterprises, (SMEs), in order to examine the implementation process through R&D, UR and OI activities in LMT firms. Innovation processes focus on R&D and UR activities in different sectors in Catalan LMT firms. We focus on the effect of implementing OI in Catalan firms along with increasing R&D productivity, which can be achieved with the help of implementing OI activities in the LMT firms, depending on the various needs of each sector. The firms' decisions to increase spending on R&D activities depend on their needs to improve their innovation in various sectors, especially LMT firms. We have selected a number of countries that have shown impressive innovation level and networks in their LMT sector; those are Sweden, Austria, Belgium, Denmark, Norway and Spain. It is notable to observe increasing awareness of the importance of innovation networks, Dittrich and Duysters¹ Chesbrough and Prencipe² and Enkel³.

In fact, OI focuses on effective ways of thinking to generate and implement processes of OI in LMT firms and OI activities analysed through both R&D and UR activities. This analysis shows the ability to understand communication skills in the innovation process practices in LMT firms through them. On the one hand firms involved in multiple types of ties are more innovative than those which only utilize one type of tie, Baum et al.,⁴ Powell and Owen-Smith⁵. On the other hand, R&D, UR and OI activities implementation process complement other tools in acquiring or developing LMT firms through analysing them. While Catalonia is not always the top-performing region in Spain on several innovation-related indicators, given its size it accounts for a large share of Spain's innovation activity and resources; Catalonia is responsible for (21%) of Spanish Research and Development investment and (33.7%) of its patents; Catalonia contains (22.5%) of Spain's innovative firms, a far greater share than other regions, the next highest shares being Madrid (15.6%) and Andalusia (15%), OECD⁶.

In practice, the implementation process of OI is of increasing importance of the R&D and UR activities. Still, it needs to be developed more fully within the culture of LMT firms. The practice of OI from different perspectives and methods needs strategies that address the implementation process through application in the fields of both firms and universities researchers, which are within a framework that transfers the implementation process of LMT firms. We need to draw a framework to describe

these practices in the concept of organizational structures. Also, it is necessary to include; the establishment of organizational roles supporting the implementation of OI; i.e., champions who lead the process of adoption of Open Innovation, Chesbrough and Crowther⁷. The implementation of OI practices is centred on the idea that; companies need to value outside competence and know-how if they are to fully exploit purposive inflows and outflows of knowledge, Van de Vrande et al,⁸.

Currently, UR and science parks, support firms in implementing OI but the process is still faces challenges and critical structural problems. R&D and UR activities actors must establish new avenues for communication that facilitate cooperation with LMT firms helping them develop their skills' and abilities and to increase the numbers of university researchers engaging in academic entrepreneurship, Shane⁹. Increasing income for universities provides opportunities and adds value to industrial sector; especially LMT firms that provide a growing share of industry funding in university income, Hall¹⁰. By increasing the cooperation between universities research centres and LMT firms, we advocate the implementation the OI process in firms. It is also important to consider the diffusion of technology transfer offices, industry collaboration support offices and science parks, Siegel et al,¹¹.

Finally, the analysis of OI focuses on different topics rather than on innovation process of OI in firms. Our main point is to focus on implementation process of OI. In practice OI needs a structure before it can be implemented. In the meantime, there is added value to R&D activities and UR activities in Catalan LMT firms that's implement OI activities. The aim of this paper is also to provide a relevant framework to focus on the innovation process, in order to sustain LMT firms and their ability to introduce successfully new products to the market. Many firms have shifted to a model of open innovation that exploits the knowledge of a wide range of actors, Chesbrough,¹². A majority of LMT studies have focused on firms from the complete range of LMT industries from across the whole of European Union (EU), Bender et al¹³ Tunzelmann and Acha¹⁴, Arundel et al.¹⁵, Hirsch- Kreinsen¹⁶, Saenz et al.¹⁷, and Huang et al.¹⁸

3.1. The Framework

Using OI concept to implement in Catalan LMT firms, we apply two- part analysis in this article. In part one, we analyse the literature of R&D and UR activities in LMT firms

and the drivers of implementing OI activities and the innovation process in Catalan LMT firms.

We analyse two plans for Catalan LMT firms in industrial sector. In first part of the framework, we analyse R&D activities and their effects on the process of implementing OI activities in LMT firms. In the second, we analyse UR activities and their effects on the process of implementing OI activities in LMT firms. Within these processes OI implementation can be applied in various ways. Existing empirical research has mostly focused on selected parts of the open innovation concept, especially the outside- in process, De Backer et al.,¹⁹, Enkel et al.²⁰, Lichtenthaler and Ernst²¹, Lichtenthaler²², West and Bogers²³. In the second part of the framework, we analyse a selected numbers of countries that have shown significant innovation level and networks in their LMT firms sector to provide indicator by which evaluate of the current situation in Catalan LMT firms.

Our framework requires a successful implementation process that depends on a standard model of OI activities in firms, the plan for the implementing OI theories in LMT firms based on the Diffusion of Useful Knowledge. According to Chesbrough et al²⁴ at its roots, open innovation assumes that useful knowledge is widely distributed and that even the most capable R&D organizations must identify, connect and leverage external sources as a core process in innovation. External sources have their influence on implementing OI activities in LMT firms. According to Laursen and Salter²⁵, innovation performance increases with both the breadth and depth of external search; i.e. with the diversity of external information sources used, and their intensity of use.

Currently, LMT firms' performances have become more innovative in the fields of LMT firms. When we choose LMT firms to pursue R&D, UR and OI activities, we first study the communication tools between R&D and UR in depth and their innovative performance in Catalan LMT firms. Dahlander and Gann's²⁶, framework offers a useful categorization of the broad concept of open innovation. We find that open innovation impacts R&D and UR performance in firms and their effects on the basis of LMT firms.

Furthermore, the concept of OI in LMT firms encourages firms to implement OI training by funding the process through R&D activities and UR activities in firms. Increased innovation performance of these firms leads others to open up for innovation activities in LMT firms since increased competition between firms forces them to improve and develop ideas externally and internally to address market

requirements and better strategic choices made by other firms, thus strengthening their competitive advantage, Bougrain and Haudeville ²⁷.

In practice, the effects of implementing OI activities can affect in the whole innovation process and increase the innovation performance of LMT firms. In terms of improving the relationships between R&D, UR activities and OI activities by using external source to acquire interaction in the innovation process of LMT firms, OI activities consider such as a relation to helps firms to increase their innovative performance using data collected through their OI activities. Michael Tushman add to this body of work by exploring the wider notion of boundary spanners, or individuals (not just with an R&D setting) who collect and exchange knowledge and information on behalf of the firm, Tushman²⁸. R&D that is interrelated with OI activities highlights many issues and requires further investigation on how firms using OI model and adapt it in their firms. When trying to apply the paradigm away from R&D models and towards SMEs and or low tech firms in traditional sectors, Spithoven²⁹ especially in countries intensive in this kind of companies, like Spain, Portugal, Italy, Chiaroni³⁰.

Our framework provides evidence from different European Union countries; (Sweden, Austria, Belgium, Denmark, Norway, and Spain and shows the impact of the implementation process of OI on their firms. By examining the implementation of OI activities in Catalan LMT firms, we try to figure out how Catalan LMT firms can implement OI activities in practice through R&D and UR activities.

At this point and according to our framework: First response on implement OI activities in LMT firms: See Table 1 [Overview of the framework]

First Response: Table 1 [Overview of the framework].

	Sweden	Austria	Belgium	Denmark	Norway	Spain
OI activities in practices	University Cooperation ³¹	Positive Impact ³²	Positive Impact ³²	Positive Impact ³²	Positive Impact ³²	Catalan R&D ³³

Table 1 [Overview of the framework, Source: Own Elaboration]

Innovation process has traditionally suffered from the implementation of new knowledge in firm. Implementation, in the context of this paper, refers to the process of applying OI activities in a new paradigm, as well as R&D and UR activities. The

development process of implementing OI will focus on firms' performance in OI activities that depend on external knowledge as they shift from a model of closed innovation to open innovation. While this phenomenon has simulated attention and interest among scholars and practitioners, there are still many areas where further investigation is needed Chesbrough & Crowther⁷. To understand the requirements to support the field of LMT firms, to understand their innovation process and what is required to be competitive in the market, we use existing literature, theoretical background and data to support our two questions:

- C. How does an open innovation tool develop solutions for LMT firms that can improve the performance through an implementation process in Catalan LMT firms?
- D. What support do LMT firms require to implement OI processes and become OI firms?

Our focus is to analyse the current situation of Catalan LMT firms, to explore the concept of OI and the influences of R&D and UR activities in the implementation of OI activities to analogous situations in European Union countries. Our framework shows the positive impact in implementing OI activities in many firms in EU countries.

3.2. Key Characteristic of the Topic

Open innovation that is characterized in LMT firms has the ability to innovate and benefit from both R&D and UR activities in the fields of innovation. There is ample evidence from the literature and theoretical background to support our framework of implementing OI activities in Catalan LMT firms through both R&D and UR activities. It is especially relevant to explain how the OI implementation processes affect LMT firms. After a review of the literature and theoretical background, we focus on three main points of R&D, UR and OI activities: 1) empirical finding in the literature of LMT firms and innovation, 2) the relationship between R&D, UR and 3) the implementation of OI in LMT firms.

First, we discovered a relationship between UR and LMT firms, that empirically suggest empirical findings that the relationships of firms with local institutions through research linkages improve the firm's capabilities; e.g. Decarolis and Deeds³⁴, McEvily and Zaheer³⁵, Lee et al.³⁶, Molina and Martinez³⁷, and Hervas and Albers³⁸, and the

size of the firm influence the utilization of knowledge in a positive and highly significant way; Carlos Vivas, Andres Barge Gil³⁹.

Second, we found out that's there are another relationship between LMT firms and R&D activities, Small sized firms present a higher R&D productivity because of their flexibility to exploit more efficiently knowledge generated outside the firm, Audretsch and Vivarelli⁴⁰, Laursen and Salter⁴¹. Additionally, small firms are constrained by their limited resources. The expansion of R&D activities both at home and in abroad, requires considerable resources both in terms of capital investment and managerial resources, that these firms simply do not have Rajneesh Narula⁴². Moreover, a fact that has been largely ignored so far, Exploring the search strategies of industrial sector in LMT firms from these sectors account for by far the largest share of modern manufacturing in terms of value-added and employment, OECD⁴³.

Third, we expect that the implementation process of OI will foster relationships between R&D, UR and LMT Firms. We reveal aspects of OI activities to explain the relationship between our selected points R&D and U&R and the implementation process of OI activities in LMT firms. Also we analyse the relationship between the outputs of U&R, R&D and LMT firms. Moreover; we adopt OI activities to implementation in LMT firms. The OI paradigm can lead to successful innovation if LMT firms are able to pave the way for it. According to Chesbrough et al.,⁴⁴, the use of purposive inflows and outflows of knowledge to accelerate internal innovation, expand it to the markets for external use of innovation respectively.

Taking this finding into account, the implementation of OI activities into LMT firms can be the way to understand OI practices. We consider the ways that certain of all elements above in the innovation process are used in OI activities while identifying the implementation process of OI activities in firms. Adaption and implementation of OI activities towered it into the firms, we will have to certain of all elements above in the process of implement OI activities into the firm. Chesbrough argues that valuable ideas can come from inside or outside the firm and can go to market from inside or outside the company as well¹². An empirical study of Korean firms show that, small companies that invest in R&D and set up systems to source ideas internally have a higher innovation output compared to small firms which do not invest in both internal activities, Hyukjoon and Parks⁴⁵.

3.3. Open Innovation Model

Our focus is to conduct the implementation process of the OI model using two purposive points as follows: A. The use of closed and open innovation, B. The use of the OI model, as external ideas as well as internal ideas to be used in the Catalan LMT firms.

A. LMT firms refer to the OI model to explore the innovation process and innovation outcomes. Both innovation process and innovation outcome can be closed or open depend on the firm, leading to 2 x 2 matrix; (See figure 1). Closed innovation reflects the situation, where a proprietary innovation is developed in-house, Chesbrough¹².

<i>Innovation process</i>	<i>Innovation outcome</i>	
	Closed	Open
Closed	1. Closed Innovation	3. Public Innovation
Open	2. Private Open Innovation	4. Open Source Innovation

Figure 1 [2 x 2 Matrix; Chesbrough,¹²]

In literature of R&D and UR activities was a relationship in the innovation process of the implementation of OI activities and them. It is important to ask when there are innovation processes outside traditional firm boundaries, what is the firm innovating? And does firm have a unique ability to change? With the democratization of both the tools of knowledge production and dissemination, many more actors outside traditional firm boundaries have access to unique solution knowledge that may be applicable to innovation tasks within firms, Jeppesen & Lakhani⁴⁶.

B. LMT refers to the OI model as external ideas and internal ideas explore the innovation process and innovation outcome, (See figure 2). In the new model of open innovation, a company commercializes both its own ideas as well as innovations from other firms and seeks ways to bring its in-house ideas to market by deploying pathways outside its current businesses. Note that the boundary between the company and its surrounding environment is porous (represented by a dashed line), enabling innovations to move more easily between the two, Chesbrough,⁴⁷.

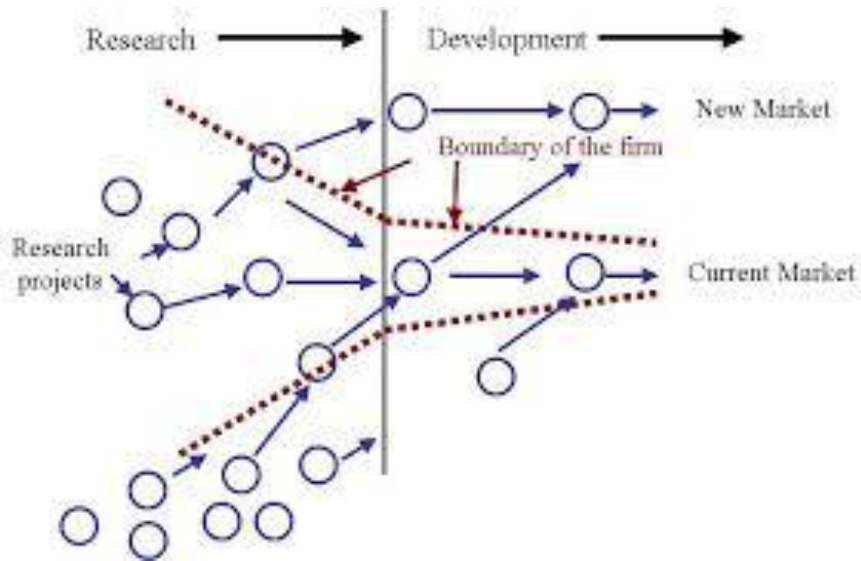


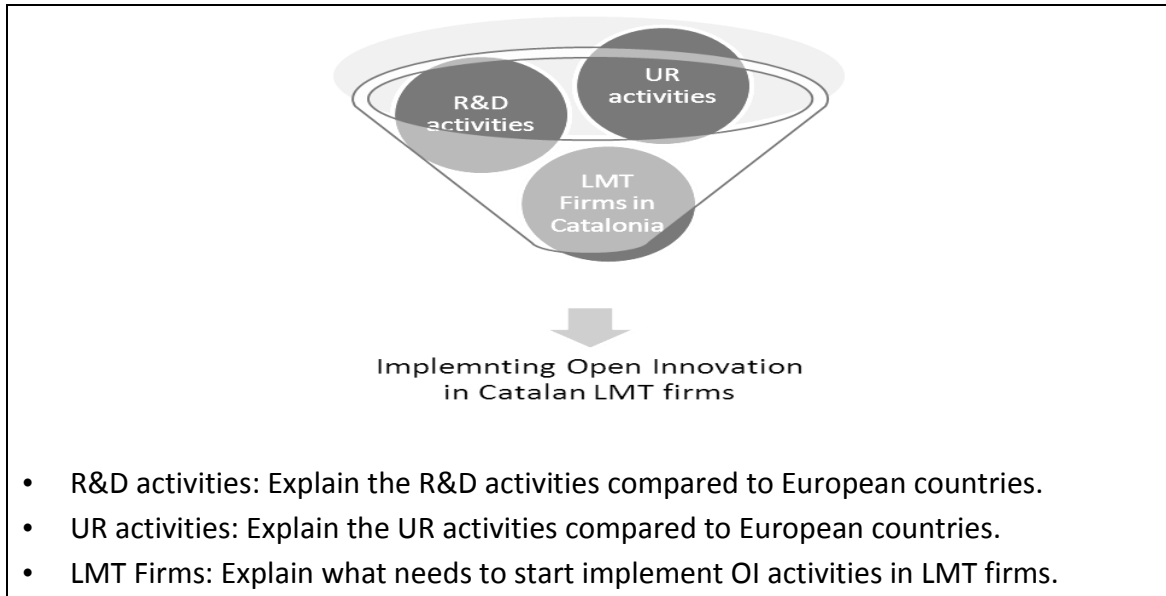
Figure 2, [the Model of open innovation; Chesbrough, 47]

3.3.1. The Model of Implementing OI Activities in Catalan LMT Firms

We draw a model for an administrative structure of Catalan LMT firms to understand. On the one hand, we show how firm can implement OI activities and communicate with other source as R&D and UR activities, on other hand, we finds ways to encourage both R&D and UR activities to increase their level of research to support Catalan LMT firms as well as the research level of EU countries. When firms start to innovate, they face a critical barrier, namely the need for firms to deal with other firm, since external knowledge from them is essential to their own development. OI implement process in their firm will help them to innovate with a higher average level than present. After a review of the literature and an evaluation of Catalan LMT firms, we determine that an administrative structure and communication mechanism between R&D, UR activities and LMT firms are important for the process of developing a firm structure and activities. Organizational structure has been shown to impact firms' effectiveness regarding the communication and processing of information, Galbraith and Nathanson⁴⁸, Mintzberg et al.,⁴⁹ Olson et al.,⁵⁰.

Empirical evidence from the literature strongly supports our observation on the effect of R&D, U&R activities and the implement of OI activities in Catalan LMT firms. We focus on the effect of implement OI activities in Catalan LMT firms and the level of investing in both R&D and UR activities that are still do not reach average EU countries Levels. There is also need to improve outcomes of UR activities in the industrial sector

and especially in LMT firms. And there is still a need for higher than average investment in both R&D and UR activities. Our model explains the process of what is needed to start implementation of OI activities in Catalan LMT firms. Fig 3 [Implementing OI in Catalan LMT firms Model].



Source: Fig 3, [The Model of Implementing OI in Catalan LMT firms, Own Elaboration]

3.3.2. The Benefit of OI Activities

Before firms shift to OI activities they need to understand: how they can decrease costs and speed up their innovation output. An important factor supporting the process of open innovation is the rising cost of technology development in many industries, Chesbrough⁵¹. That is when firms start to understand the implementation of OI activity mechanisms can be beneficiary. We assume that; SMEs are able to integrate and utilize OI activities, since they can reduce the challenges related to “liability of smallness” and finite resources in the context of innovation, Chesbrough, Vanhaverbeke, and West⁵², Laursen and Salter²⁵. Make a strong case for how OI search strategy and search channels influence the innovation performance of SMEs. Altogether, firms increase their abilities and skills, as they shift from non OI activities to OI activities and to use their internal and external source to ensure the access of new ideas into the firm, from both internal and external ideas; innovators rely heavily on their interaction with a range of lead users, suppliers, firms, universities, research laboratories, institutions in the innovation system, Von Hippel⁵³ Su, Tsang, and Peng,

⁵⁴.

The benefit of R&D and UR activities relies on ensuring implementation process of OI activities in their firms; According to Chesbrough and Crowther,⁷. Who state that, for ensuring full implementation of open innovation strategy, the role of innovation champions are integral to understanding the process of how to implement OI activities in their firms. These different processes show why it is necessary to have a full understanding of how and where open innovation can add value in knowledge-intensive processes Ellen Enkell⁵⁵, Oliver Gassmann⁵⁵ and Henry Chesbrough⁵⁵ Understanding the mechanism of OI activities will help a firm to shift to OI activities and to start OI behaviours in their firms. To restate a fundamental point: in order to sustain the ability to introduce new products to the market successfully; many firms have shifted to a model of 'open innovation' that exploits the knowledge of a wide range of actors, Chesbrough,¹². Firm add value, they ensure, understand and shift to OI activities into their firms.

At this point and according to our framework: Second response on how to start implement OI activities in Catalan LMT firms: we introduce table 2: Overview of Implementing OI activities in Catalan LMT Firms Our Model of Catalan.

Second Response: Table 2 [Overview of Implementing OI activities in Catalan LMT firms]

Catalan LMT Firms	Ensuring Implementation Of ⁷ OI activities	Understanding the process Of ⁵³ OI activities	LMT firms Shift To ¹² OI activities
--------------------------	---	--	--

Table 2 [Overview of Implementing OI activities in Catalan LMT Firms, Own Elaboration]

3.3.3. Open Innovation and Practices

Defining the framework of OI activities in this paper is to understand the relationship between OI activities and LMT firms in practices. Many LMT firms implement OI as a new concept, showing positive impacts in several EU countries whose firms implemented OI activities. OI practices has become increasingly adapted in LMT firms whose development has been based on previous literature, Pisano and Verganti⁵⁶, Chesbrough and Crowther,⁷.LMT firms are relevant to OI activities providing both opportunities and obstacles for understanding the implementation process of OI activities. Also despite the rich and growing body of research in the field, there is not yet a full understanding of how companies manage to actually implement open innovation practices and overcome critical barriers to operation, Huizingh,⁵⁷.We

assume that's for firms to start choosing, implementing and adapting OI activities, they must ensure, understand the process beforehand. Many firms start to implement open innovation as a necessary organizational adaptation to changes in the environment, Chesbrough,¹².

At this point and according to our framework: Third response on implement OI activities in LMT firms: Our Model of Open innovation in practices; offer the benefit of Implement OI activities and the critical points in the field. See Table 3.

Third Response: Table 3 [Overview of Open innovation practices]

Open innovation	Critical Barriers	A necessary Adaption
in Practices	Huizingh ⁵⁷	Chesbrough ¹²

Table 3 [Overview of Open innovation practices, Own Elaboration]

First, according to Huizingh [58] “Critical barriers to operation”, we review the literature on critical barriers in the field of OI activities. We found that when it comes to implement of OI activities, there are critical barriers that firms face as they start to adapt and understand them. In this paper, we identify the critical barriers that Catalan LMT firms face. Critical barriers are different from firm to firm, and each individual firm has its own critical barriers, when it comes to implementing OI activities. Van de Vrande et al.⁵⁸ shows that the organizational and cultural issues which arise when companies start to interact and collaborate with external partners were the main barrier to the implementation of open innovation strategies in Dutch SMEs. At this point, each firm has their own critical barriers and it will be different from firm to firm and country to country. We should consider that's when we start to analysis the OI implementing process.

Second, according to Chesbrough,¹² there is “a necessary organizational adaption”, when we start to adapt OI activities as necessary to our firms, we should consider the differences in the situation from country to another, over the last decade, a number of tools and management techniques have been developed to facilitate integrating the activities of partnering firms, Slowinski and Sagal,⁵⁹.This discussion leads us to focus on how to start implementing OI activities the necessity for them to be adapted and how to identify the positive impact and the critical barriers that's Catalan LMT firms face when it comes to implement OI activities.

3.4. Implementation of OI Activities in Catalan LMT Firms

LMT firms were converted into OI activities shown a positive impact on the firms that's adapted the OI activities. We evaluate what is necessary for the OI implementation process in Catalan LMT firms. The aim of this paper to improve the innovation potential of LMT firms and to evaluate, administrative structures that will best facilitate implementation of OI activities within Catalan LMT firms. It is essential to understand relationship between R&D, UR and OI activities and to know how, where and when OI activities can add to Catalan LMT firms both locally in Spain and regionally in EU countries. Access to expanded business and knowledge networks helps firms, particularly small and medium-sized enterprises, (SMEs) that may not be able to source globally to the same extent as large firms, OECD, ⁶⁰.

3.4.1. Evaluation of Catalan LMT Firms

The data cited in this chapter are used to describe the implementation process of OI activities in Catalan LMT firms. Our data, from the years (2007 to 2013), is derived from several sources, including: Micro, Small and Medium Enterprises of Catalonia, (PIMEC), Organisation for Economic Co-operation and Development, (OECD) and data is based on study of Agustí Segarra and Mercedes Teruel. And study of Maribel Guerrero, David Urbano, James Cunningham and Damien Organ.

There are three steps to our recommended evaluation process for LMT firms in Catalonia, all designed toward creating opportunities overcoming the moribund current economic situation in Catalonia.

First step: Section I, Low- Medium Tech, firms in Catalonia: In this section we cover two points: First, we take into account the value added per unit sold Catalan SMEs. Second, we look at the productivity per worker by company size to get an overview of productivity to operating costs of LMT firms. According to PIMEC yearbook for 2013 Catalan (SMEs) Economic and financial results for the year; 2007-2011:

In absolute terms, the productivity per worker by company size in 2011 was € 93,444 in large companies, 47% higher than the Catalan average. In contrast, the rate of in SMEs is shown to be € 50,874, 20% less than the Catalan enterprises average.

Again looking at company size, the least productive SMEs are those with no employees showing productivity rates that are 43% lower than the Catalan average, Table 4, ⁶¹.

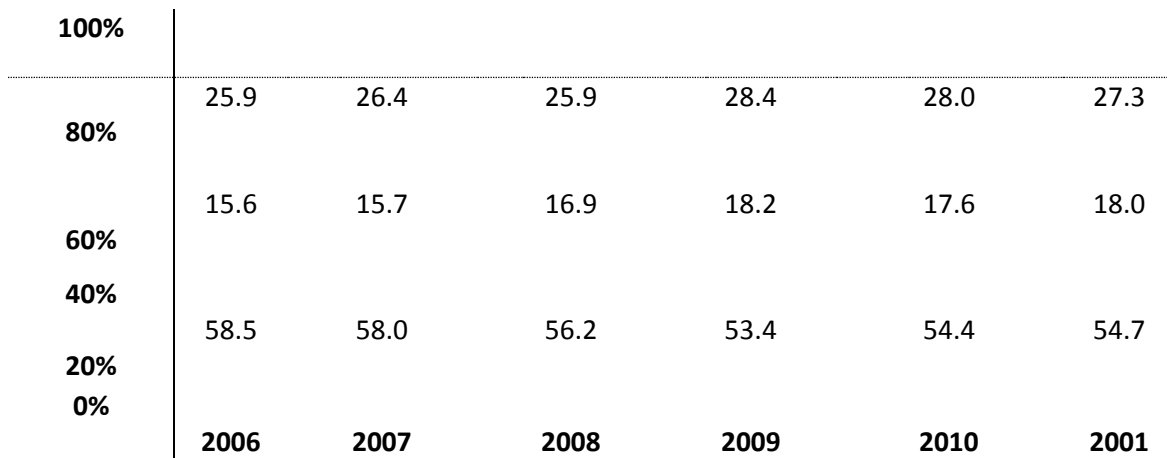
Table 4 [Evolution of labour productivity, by company size. 2007-2011]

Rates of change						
	2011	2010	2009	10-11	09-10	08-09
SMEs with no Employees	35.981	37.201	37.008	-3,3%	0,5%	-17,6%
SMEs with Employees	53.724	53.117	52.604	1,1%	1,0%	0,9%
Micro Enterprises (1 to 9 employees)	46.611	45.751	46.399	1,9%	-1,4%	-2,3%
Small Firms (10 to 49 employees)	52.550	50.933	51.638	3,2%	-1,4%	1,6%
Averages (50 to 249 employees)	62.770	63.549	60.416	-1,2%	5,2%	2,9%
Total SMEs (≤ 250 employees)	50.874	50.643	50.143	0,5%	1,0%	-1,8%
Large Firms (≥ 250 employees)	93.444	86.325	86.112	8,2%	0,2%	3,5%
Total Companies	63.400	61.077	60.269	3,8%	1,3%	0,5%

Source: [PIMEC, 2013]

The value added per unit sold Catalan SMEs decreased in 2011 compared to 2010. Income generated by euro turnover, measured in terms of Gross Value added (GVA), from 28.0% in 2010 to 27.3% in 2011, a figure, it should be noted, is higher than those obtained between 2006 and 2008. The reduction in value is explained both by the increase in consumption operating income, (+0.4 percentage points compared to 2010) and for other operating expenses (which increased 3 percentage points). In the long term, we observe that the increased weight of GVA and other operating costs at the expense of consumption exploitation, although this trend is not constant, figure 4, ⁶¹.

Figure 4 [Basic structure of the income of Catalan SMEs, 2007-2011]



- Value
- Other Operating Expenses
- Utilities Operating

Source: PIMEC, [From SABI DATA, ⁶¹]

Second step: Section II, R&D activities in Catalan LMT firms: In this section the analysis based on test of complementarity between R&D activities sources by sectors and structure of GVA of the Catalan economy. According to Agustí Segarra and Mercedes Teruel ⁶², productivity increases significantly when a new R&D activity is added to an existing one compared to situations where there is no previous experiences in R&D activities. Our results show that carrying out internal and external R&D had a significant positive impact on productivity for high-tech manufacturing industries, whereas this positive relationship was not significant for the low-tech manufacturing and service industries, Table 5, ⁶².

Table 5 [Test for complementarity between R&D sources]

	F-value	Probability
Whole database	0.90	0.3440
High-tech manufacturing industries	3.99	0.0461
Low-tech manufacturing industries	0.69	0.4049
Knowledge-intensive services	0.02	0.8999

Note: We test the following equation: $-buy\ only - make\ only + make\ buy = 0$. Source: [Agustí Segarra & Mercedes Teruel: Productivity and R&D sources: evidence for Catalan firms, ⁶²].

Third step: Section III, UR average Level and LMT firms: In this section the analysis based on studies of Maribel Guerrero, David Urbano, James Cunningham and Damien

Organ ⁶³, According to them, The Autonomous University of Barcelona (UAB) has been characterized by its participation in a high number of research projects. These research projects have been the result of partnerships among the university, industry and regional government, which have facilitated UAB's knowledge transfer in the regional industry. The Technical University of Catalonia (UPC) has also had an important influence on regional development because of the partnerships it has promoted between itself and the local industry for the past 10 years. As with UAB, these partnerships have generated, in turn, an important infrastructure for regional development (e.g., National Centre of Accelerations, Quantico Ecological Station, and Microelectronic National Centre, among others).

Summaries: Table 6. The methods used for data-gathering are based upon a systematic application of the embedded multiple case-study approach. To triangulate the case findings and enhance the validity and reliability of the study, Yin, ⁶⁵ several sources and archival material were collected from 2006 to 2010 for all case-study universities, Maribel Guerrero, David Urbano, James Cunningham and Damien Organ, ⁶³.

Table 6 Entrepreneurial Universities Selected

Region	University	Type	Founded	Rank	Distinctive	Entrepreneurial Characteristics
Spain	UAB	Broad-based	1968	238		Collaboration with the government and industry in entrepreneurial activities.
	UPC	Technological	1968	145		Relationship with the industry for more than 10 years. Assume the technological change.
Ireland	NUIG	Broad-based	1845	602		Collaboration with regional and national industry and government agencies. Distinctiveness prestige and status in research, teaching and service to community.
	UL	Technological	1972	614		Alliances in technological, research and teaching activities and history of a close relationship with the industry.

A. Regions characterized by higher levels of entrepreneurship measured by the number of new enterprises (GEM 2010)

B. UAB Autonomous University of Barcelona, UPC Technical University of Catalonia, NUIG National University of Ireland Galway, UL University of Limerick.

C. World Rank (Webometrics 2010).

Source: studies of Maribel Guerrero • David Urbano • James Cunningham • Damien Organ, ⁶³

3.4.2. The Importance of R&D and UR Activities in LMT Firms

Empirical results supports the view of this phenomenon, as we draw our framework and the evaluation process of LMT firms in EU countries and Catalonia, after reviewing the literature review and writing our framework. We focus on two main points to understand the needs of the implementation process of OI activities in LMT firms in EU countries and Catalonia as follow:

A. This is a preview of R&D activities, we found that it is important to support LMT firms through R&D activities as shown from different EU countries; the need appears disproportionate given that mature LMT industries still make up the largest part of the manufacturing industries in OECD countries and that their preponderance is falling at a very slow rate, Kaloudis et al, ⁶⁵. Most previous studies have focused on the importance of R&D activities as the determinant of innovation, Hirsch-Kreinsen et. al, ⁶⁶. The ability of LMT firms to innovate depends on support from external R&D activities in the sector of LMT firms.

B. This is a preview of UR activities; we found that it is important to support LMT firms through UR activities and research unit. Firstly, in order to investigate the link between universities and industrial innovation, we build upon a number of studies exploring the factors that shape the propensity of firms to draw from universities in their innovative activities, for instance; Spencer, ⁶⁷ Cohen et al ⁶⁸. Secondly, evaluating Catalan LMT firms; as we discussed above the study of Agustí Segarra and Mercedes Teruel ⁶². And the study of Maribel Guerrero, David Urbano, James Cunningham and Damien Organ, ⁶³. Show the importance of both R&D and UR activities in Catalonia and their effect on the OI implement process. There needs to be an increase in the average level of both. There is also a need to develop an administrative structure in order to understand the communication paths between LMT firms and R&D, UR activities in the field.

3.5. Discussion and Analysis

We found out that in answering first and second question here remains a need in Catalonia to increase investment in both R&D and UR activities to develop LMT firms in industrial sector. Evidence from several countries in Europe shown impressive positive impact on implementing OI activities in their LMT firms, as shown in our framework

those countries are Austria, Belgium, Denmark and Norway, they have higher average levels of investing in both R&D and UR activities that help their LMT firms adapt and implement OI activities compared to Catalonia . Our results to the two questions are as follow:

3.5.1. How does an open innovation tool develop solutions for LMT firms that can improve the performance through the implementation process in Catalan LMT firms?

Our plan to implement OI activities in LMT firms depend on the analyses of literature in the fields of implement OI activities in LMT firms. According to an analysis of our framework we find the following response:

First response:

[See Table 1]. Overview of the framework: The framework definition: to support our structure designed to describe the requirements of the implementation process of OI activities in EU countries and to compare those requirements with our plan to implement OI activities in Catalan LMT firms. We notice from a study of LMT firms in various EU countries (Sweden, Austria, Belgium, Denmark, Norway and Spain).

A. We notice from a study of Vinit Parida, Christian Johansson, Tobias C. Larsson³¹ Experience of LMT the importance partnerships have to SMEs wishing to implement OI practices. Also those SMEs that had collaborations with UR were easier for partnership and regarded as a convenient for collaboration.

B. We notice from a study of Carter Bloch, Sverre J. Herstad and Els Van De Velde³² the results indicate that R&D intensity is still an important determinant of innovation performance, and there is some mixed evidence that sourcing breadth has positive impact particularly in Norway, but none for sourcing depth with a negative impact on novel innovativeness in Belgium.

C. We notice from a study of Lluís Santamaría, María Jesús Nieto, Andrés Barge-Gil³³ these results could have important implications for R&D managers. Internal R&D performers are more likely to achieve innovations when OI strategies are implemented, in both high and low-tech industries. We find out that's R&D and UR have their influence in the process and performance of implement OI activities.

Second response:

[See Table 2]. Overview of Implementing OI in Catalan LMT Firms: When firms start to ensuring, and, understanding the implement process of OI, they will be able to shift into OI activities. A lack understanding of perquisites for necessary for OI implementation makes it difficult for LMT firms to shift into OI activities: Our overview of Catalan LMT firms; offer how firms act when starting to shift to implement OI activities in Catalonia.

Third Response:

[See Table 3]. Overview of Open Innovation Practices: According to Huizingh⁵⁵ there has always been “Critical barriers to operation”, in the field of innovation and it is important for firms to understand how to identify and face these critical barriers before implementing OI activities. We found out that there are critical barriers in Catalan LMT firms in the field of R&D and UR activities. In these studies we found that the high average level of both R&D and UR activities will help firms to implement OI activities and to have a positive impact in there LMT firms.

3.5.2. What support do LMT firms require to implement OI processes and become OI firms?

Our responses on this question, we figure out in our three section of the evaluation process of Catalan LMT firms, are as follow:

Section I: Low/ Medium Tech, firms in Catalonia: We found that in Table 4, the least productive firms are SMEs with no employees. We also found in figure 4 that the income generated by Euro turnover decreased in 2011 compared to 2010. We conduct the current analysis to show that among LMT firms in Catalonia. SMEs with no employees, with productivity 43% lower than the Catalan average.

Section II: Research & Development activities and Catalan LMT firms: We found out that’s in Table 5, internal and external R&D, was not significant for the low-tech manufacturing and service industries. In the meantime according to figure 5, Catalan GVA in 2011 was 48.4%, 2.9 percentage points lower in 2010. As shown in figure 5, the LMT firms from the biggest sector in Catalonia. We note that GVA decreasing in 2011. At this point we try to understand the process of R&D activities relative to the size of

LMT firms in Catalonia. We determine there is a need for greater investment in the R&D activities for LMT firms in Catalan industrial sector to increase the productivity.

Section III: University Researches and Catalan LMT firms: In Table 6, we found according to Guerrero, Urbano, Cunningham and Organ⁶³, when we compare these regions in terms of productivity by researcher, there is a great distance between Catalonia and Ireland that might be caused by the specific context of each region. As shown above from different EU countries, there is positive impact of UR activities when they implement OI activities in their firms, but those EU countries still have higher average level of UR activities than Catalonia region.

Finally, our plan to implement OI activities in Catalan LMT firms depends on comparing of how LMT firms in other EU countries implement OI activities as well as assessing. Analysing the literature, we determine that the benefits of OI activities depend on Ensuring and understanding of what is necessary for implementation process of OI activities before firms shift to them. We affirm greater success in firms that start to collaborations in R&D and UR activities in several EU countries. The current situation of Catalan LMT firms shows that LMT firms outcomes different on LMT firms' outcomes from Several EU countries.

3.6. Concluding Remarks

The framework of this study is divided into two parts. The first part analyses, both the literature of OI activities and the current situation of Implement OI activities in several EU countries and compares it to the evaluation process of Catalan LMT firm's fields. The three responses to the framework are as follow: First response, we determine that UR activities were easy to access and regarded the implementation process of OI activities. Also we found that the intensity of R&D is important of the innovation performance and outcome, which helps in the process of implementation OI activities. [See Table 1, Overview of the Framework].Second response, within Catalan LMT firm still there is a need for firms to ensure the process of implementing OI activities as well understanding the process of OI activities and how firms can apply new ideas from their external source that can help the firm innovate and increase their innovation outcomes. [See Table 2, Overview of Implementing OI in Catalan LMT Firms].Third response, we determine critical points for the firms to undertake R&D and

UR activities in the fields of open innovation. Critical points both inside firms, as well as externally that can support the process of implement OI activities. [See Table 3, Overview of Open Innovation Practices].

The evaluation the implementation process of OI activities is divided into the three sections. We evaluate the current situation of Catalan LMT firms' situation according to our framework analysis of firms in several EU countries. In section one, the data explain that LMT firms in Catalonia are still is the largest part of the industrial sector, standing at 48.8 % of the whole sector. We also show decreased growth of this sector in the year of 2011 compared to 2010. In section II and III we found that to ensure the process of implement OI activities in the sector of LMT firms, there must be an increase in the average level of both UR activities and R&D activities. Research of LMT firms in several EU countries shows the importance and the influences of these sectors on the process of OI activity implementation.

LMT firms in Catalonia face critical barriers and challenges, but there are also positive indicators in Catalonia of both sectors of UR and R&D activities that help them to think regionally and not locally. The structure of R&D and UR activities encourages them to increasing their spending on such activities in regard to the LMT sector in Catalonia, or as Chesbrough¹², mentions "A necessary organizational adaption", that encourages firms to start to adapt the theory of OI activities in their firms. This article addresses the issue that when firms start to implement OI activities, the needs of Catalan LMT firms increase innovation outcomes of R&D and UR activities as external source of knowledge to match LMT firms in other EU countries.

We found that OI takes place at different firm level. When we are chose to investigate Catalan LMT firms, we responded to the need to understanding this sector to understand how Catalan LMT firms can implement OI activities by comparison to firms in other EU countries. We determined there remain many other tools to understand before one can start to implement OI activities. On of this tool is to increase the average level of R&D and UR outcomes in industrial sector and especially LMT firms.

3.7. References (Chapter 3)

- [1] K. Dittrich and G. Duystres: networking as means to strategy change: the case of open innovation in mobile telephony. *Journal of Product Innovation Management*, 2007, 24, 6, 510-521.
- [2] H. Chesbrough and A. Prencipe: Networks of innovation and modularity: a dynamic perspective, *International Journal of Technology Management*, 2008, 42, 4, 414-425.
- [3] E. Enkel: Attributes required for profiting from open innovation in networks, *International Journal of Technology Management (In Press)*, 2010, 344- 371.
- [4] J.A.C. Baum, T. Calabrese, and B.S. Silverman: Don't go it alone: alliance network composition and startup's' performance in Canadian biotechnology, *Strategic Management Journal*, 2000, 21 (3), 267–294.
- [5] W.W. Powell, J. Owen-Smith, Network position and firm performance: organizational returns to collaboration in the biotechnology industry. *Research in the Sociology of Organizations*, 1999, 16, 129–159.
- [6] OECD, Reviews of regional innovation, Catalonia, Spain. *OECD Paper*, 2010, 1995- 6585 online.
- [7] H. Chesbrough, A.K. Crowther: Beyond high-tech: early adopters of open innovation in other industries, *R&D Management*, 2006, 36,229–236.
- [8] V. V De Varande, J. P. J. D. Jong, and W. Vanhaverbeke & M. D. Rochemont: Open innovation in SMEs: Trends, motives and management challenges, *Technovation*, 2009, 29, 423 – 437.
- [9] S. A. Shane: Economic Development through Entrepreneurship: Government, *University and Business Linkages*, Cheltenham: Edward Elgar, 2005.
- [10] B. H. Hall: University- industry partnerships in the United State. In Contzen, J.-P., Gibson, D. and Heitor, M.V. eds, *Rethinking Since Systems*, 2004.
- [11] D.S. Siegel, D. Waldman and A. Link: Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study, *Research Policy*, 2003, 32, 27 -48.
- [12] H. Chesbrough: Open Innovation—the New Imperative for Creating and Profiting from Technology, *Harvard Business School Press, Boston*, 2003.

- [13] G., D. Bender, Jacobson and P. L. Robertson: Non-Research-Intensive Industries in the Knowledge Economy, Published in Perspectives on Economic Political and Social Integration, *Special Edition XI*, 2005, No 1-2.
- [14] N. Tunzelmann von and V. Acha: 'Innovation in "Low-Tech" Industries', in J. Fagerberg, D. Mowery and R.R. Nelson (eds), *The Oxford Handbook of Innovation*. Oxford University Press: Oxford, 2005, pp. 407–432.
- [15] A. Arundel, C. Bordoy and M. Kanerva: 'Neglected innovators: How do innovative firms that do not perform R&D innovate? .Results of an analysis of the Inn barometer 2007 Survey No. 215, *INNO-Metrics. Thematic Paper*, 2008, MERIT March 31.
- [16] H -Kreinsen, H: Low-tech, innovations. *Industry & Innovation*, 2008, 15, 19–43.
- [17] J. Sáenz, N. Aramburu and O. Rivera, 'Knowledge sharing and innovation performance: A comparison between high-tech and low-tech companies', *Journal of Intellectual Capital*, 2009, 10, 22–36.
- [18] C. Huang, A. Arundel and H. Hollanders: 'How firms innovate: R&D, non-R&D, and technology adaption', *The UNU-Merit Working papers series*, 2010-027.
- [19] K. De Backer, K.V. Lo´pez-Bassols, and C. Martinez: "Open innovation in a global perspective: what do existing data tell us?", OECD Science, *Technology and Industry working papers, 2008/4, OECD Publishing, OECD, Paris*, 2008.
- [20] E. Enkel, O. Gassmann, and H. Chesbrough: "Open R&D and open innovation: exploring the phenomenon", *R&D Management*, 2009, pp. 311-6.
- [21] U. Lichtenthaler and H. Ernst: "Opening up the innovation process: the role of technology aggressiveness", *R&D Management*, 2009, pp. 38-54.
- [22] U. Lichtenthaler: "Outbound open innovation and its effect on firm performance: examining environmental influences", *R&D Management*, 2009, pp. 317-30.
- [23] J. West and M. Bogers: Contrasting innovation creation and commercialization within open, user and cumulative innovation, *working paper, San Jose´ State University, San Jose, CA*, 2010.
- [24] H. Chesbrough. W. Vanhaverbecke and J. West: Open Innovation: Researching a New Paradigm, *Oxford University Press*, 2006.

- [25] K. Laursen and A. Salter: Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms, *Strategic Management Journal*, 2006, 27: 131-150.
- [26] L. Dahlander and D. M.Gann: How Open is Innovation? *Research Policy*, 2010, 39, 699–709.
- [27] F. Bougrain, H.B. Haudeville: Innovation collaboration and SMEs internal research capacities. *Research Policy*, 2002, 31, 735–747.
- [28] ML. Tushman: Technical communication in R&D laboratories: The impact of project work characteristics. *Academy of Management Journal*, 1977, 20, 624–645.
- [29] A. Spithoven: Building absorptive capacity to organize inbound open innovation in traditional industries, *Technovation*, 2010, 30,130-141.
- [30] D. Chiaroni: The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm, *Technovation*, 2011, 31, 34-43.
- [31] V. Parida, C. Johansson, and T. C. Larsson: Implementation of Open Innovation practices in Swedish manufacturing industry, *International Conference On Engineering Design*, 2009, ICED'09.
- [32] B. Ebersberger, C. Blosch, S. J. Hestad, E. V. De Velde: Open innovation practices and their effect on innovation performance, *International Journal of innovation and Technology management*, 2010.
- [33] L. Santamaria, M.J. Nieto, A. Barge- Gil: The relevance of different Open Innovation strategies for R&D performance, *Cuadernos de Economia y Direccion de La Empresa*, 2010, 45, 1138- 5758.
- [34] D. M. Decarolis, D.L.: the impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry, *Strategic Management Journal*, 1999, 20, 953-968.
- [35] B. McEvily, A. Zaheer, B. Ties: a source of firm's heterogeneity in competitive capabilities, *Strategic Management Journal*, 1999, 20, 1133-1156.
- [36] Ch. Lee, K. Lee, and J. Pennings: Internal capabilities, external networks, and performance: a study on technology-based Ventures, *Strategic Management Journal*, 2001, 22, 615- 640.

- [37] X. Molina and T. Martinez: How Much Difference is there between Industrial District Firms? A Net Value Creation Approach, *Research Policy*, 2004, 473-486.
- [38] J.L. Hervás-Oliver, J. Albors-Garrigós: The Role of the Firm's Internal and Relational Capabilities In Clusters: When Distance And Embeddedness Are Not Enough, *Journal of Economic Geography*, in press, 2009.
- [39] V. A. Carlos and B. G. Andres: Impact on firms of the use of knowledge providers: a systematic review of the literature, *Munich Personal RePEc Archive, MPRA Paper*, 2012, 41042, 16:22.
- [40] D. Audretsch and M. Vivarelli: Firm size and R&D spillovers: evidence from Italy, *Small Business Economic*, 1996, 9, 249:258.
- [41] K. Laursen, A. Salter: Searching high and low: what types of firms use universities as a source of innovation? *Research Policy*, 2004, 33, 1201:1215.
- [42] R. Narula: R&D collaboration by SMEs: new opportunities and limitations in the face of globalisation, *Technovation*, 2004, 24, 153:161.
- [43] OECD: Science, Technology and industry Outlook, *OECD Paris*, 2006.
- [44] H.W. Chesbrough, A. K. Crowther: Beyond high tech: early adopters of open innovation in other industries. *R&D Management*, 36, 229:236.
- [45] H. Kim. & Y. Park: The effects of open innovation activity on performance of SMEs: The case of Korea, *International Journal of Technology Management*, (forthcoming), 2010.
- [46] LB, Jeppesen KR, Lakhani: Marginality and problem-solving effectiveness in broadcast earch. *Organization Science*, 2010, 21, 1016:1033.
- [47] H.W. Chesborugh: The era of open Innovation, *MIT Sloan Management Review*, spring, 2003, 515: 35:41.
- [48] JR, Galbraith, DA. Nathanson DA: Strategy Implementation: The Role of Structure and Process, St. Paul, Minnesota: West Publishing Company, 1978.
- [49] H. Mintzberg, IJ Lampe, J Quinn, S Ghoshal: The Strategy Process: Concepts, Contexts and Cases (4th ed.). Upper Saddle River, New Jersey: Prentice-Hall, 2003.
- [50] EM. Olson, OC. Walker, Rw. Ruekert: Organizing for Effective New Product Development: The Moderating Role of Product Innovativeness. *Journal of Marketing*, 1995, 59(1):48-62.

- [51] H. Chesbrough: Why companies should have open business models. *Sloan Management Review*, 2007, 48, 22-28.
- [52] H. Chesbrough, W. Vanhaverbeke, and J. West, Eds: Open Innovation: Researching a New Paradigm. *New York: Oxford University Press*, 2006.
- [53] E.Von Hippel: The sources of innovation. *New York: Oxford University Press*, 1988.
- [54] Su, Y.S., Tsang, E.W.K., & M. W. Peng: How do Internal Capabilities and External Partnerships Affect Innovativeness? *Asia Pacific Journal of Management*, 2009, 26, 309:331.
- [55] E. Enkel, O. Gassmann and H. Chesbrough: Open R&D and open innovation: Exploring the phenomenon, *R&D Management*, 2009, 39, 4.
- [56] G. P. PISANO& R.VERGANTI: What Kind of Collaboration Is Right for You? *Harvard Business Review*, 2008, 86, 78-87.
- [57] E. K. R. E. HUIZINGH: Open innovation: State of the art and future perspectives. *Technovation*, 2011, 31, 2-9.
- [58] V. De Vrande, J. P. J. D. Jong, W. Vanhaverbeke, and M. D. Rochemont: Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 2009, 29, 423-437.
- [59] G. Slowinski and M.W.Sagal: The Strongest Link: Creating Profitable and Enduring Corporate Partnerships. *New York, AMACOM Press*, 2003.
- [60] OECD, Reviews of Regional Innovation, Regions and Innovation Collaborating across Borders, *OECD Paper*, 2013, ISBN 978-92-64-20530-7 (PDF)
- [61] PIMEC, Anuario de la Pime Catalana. Resultas Economics I Financiers, *PIMEC Paper*, 2007- 2011, 2013, B-18670-2013.
- [62] A. Segarra & M. Teruel: Productivity and R&D sources: evidence for Catalan firms, *Economics of Innovation and New Technology*, 2011, 727-748.
- [63] M. Guerrero, D. Urbano, J Cunningham, D, and Organ: Entrepreneurial universities in two European regions: a case study comparison, 2012, 10.1007/s10961-012-9287-2.
- [64] Yin, R: Case study research, design and methods. *Beverly Hills, CA: Sage*, 1984.
- [65] A. Kaloudis, T. Sandven, K. Smith: Structural change, growth and innovation: the roles of medium and low-tech industries, 1980–2002. In: Bender, G., Jacobson, D., Robertson,

P.L. (Eds.), Non-Research-Intensive Industries in the Knowledge Economy. *Journal for Perspectives on Economic Political and Social Integration*, 2005, 11, 49–73.

- [66] H. Hirsch-Kreinsen, D. Jacobson, S. Laestadius, and K. Smith: Low and medium technology industries in the knowledge economy: the analytical issues. In: Hirsch-Kreinsen, H., Jacobson, D., Laestadius, S. (Eds.), *Low-tech Innovation in the Knowledge Economy*. Peter Lang, Frankfurt Main, 2005, pp. 11–30.
- [67] J. W. Spencer: How relevant is university-based scientific research to private high-technology firms? A United States–Japan comparison. *Academy of Management Journal*, 2001, 44, 432–440.
- [68] M. W. Cohen, R. R. Nelson, and J. Walsh: Links and impacts: the influence of public research on industrial R&D, *Management Science*, 2002, 48, 1–23.

Chapter 4

External Source of knowledge as an Open innovation (OI) tool: A comparison of Open-Alps Platform and the Catalan ICT Sector

ABSTRACT

Innovation research is based on case studies from Catalan, ICT Sector and Open-Alps, Platform, in the field of Small and Medium Enterprises (SMEs) and Low Medium Technology (LMT) firms. The objective of the paper is to extract external source of knowledge for SMEs and LMT firms and to compare the innovation levels in Catalonia and Open-Alps project. We determine the OI goals and the way to achieve them and analyse the use of external sources of knowledge, in order to understand their innovation processes. Our aim is to discuss two cases from two different countries and provide empirical evidence to justify the difference between them. Open-Alps is a European Union project in Alpine region of Alps. It is a SMEs/LMT project and we compare it with the technology sector in Catalonia on how each of them relies on external source of knowledge in the innovation process of their SMEs/ LMT firms? On the other hand, we focus on a descriptive statistic to understand the innovation level and the difference between Catalan and the Open-Alps SMEs/ LMT firms in the industrial sector. These case studies are used as empirical findings in order to obtain evidence of using OI activities in SMES/ LMT firms. We identify both case studies including the points of weakness and the strength between the two cases through data samples from 2011 to 2013.

Introduction

In recent years, OI activities have helped firms to innovate and implementing them in the structure of the firm has become very important. We review the field to understand the innovation level that has been used by different firms regionally in several European Union countries (EU) and locally in Catalonia, Spain. As innovation becomes a driving factor for different firms, we evaluate two case studies to discuss the differences between them, to understand how they use the external source of knowledge in the case of Catalan SMEs/ LMT firms and compare it with the Open-Alps case? These two cases are handled separately in two different countries in science and technology in SMEs/ LMT firms in the industrial sector; External sources of knowledge and innovation have become increasingly relevant Porter and Stern¹.most studies distinguish between purposive out-flows and inflows of knowledge to accelerate internal innovation processes and to better benefit from innovative efforts, respectively, e.g. Chesbrough et al.,²; Chesbrough and Crowther,³.

In order to help SMEs/ LMT firms innovate, we focus on external sources of knowledge to find the relation between the two case studies of Catalonia and Open-Alps. In this context, we rely on the difference in innovation processes between the two cases and analyse the strength and weakness to understand the current position and evolution trends; SWOT analysis, meaning the analysis of 'key' or 'critical' success factors, belongs to the highest ranked set of techniques of strategic analysis used by firms in empirical surveys, Glaister and Falshaw⁴.

The increasing needs of innovation in the field of SMEs/ LMT firms have shown what already exists and what needs to improve in LMT firms. The differences in the two case studies and their aim to increase their innovation levels has shown avenues to increase productivity through competitor, which innovation processes they use in their field based on their OI activities. Innovation is a key goal of firms to focus on external sources of knowledge; Von Hippel⁵. We identified four external source of knowledge: 1) suppliers and customers; 2) university, government and private laboratories; 3) competitors; and 4) other nations.

To increase the level of using external source of knowledge in the firm for OI activities which is considered an advantage for firms. The main advantage is that external source of knowledge have become more important to firms who wish to achieve innovation levels often compared to evaluation the process of other firms;

Chesbrough^{6,7}; suggests these changes are creating a new model of innovation called Open Innovation (OI). This model involves the firm working with a range of external actors, integrating these actors with their internal ideas and find profitable new combinations. It is often argued that firms who are 'too internally focused' are 'prone to miss a number of opportunities' because many fall outside the organization's current business or will need to be combined with external technologies to unlock their potential. Firms that wish to achieve innovation processes are often evaluated in comparison with other firms.

For instance, it is established that OI activities through interaction with external source of knowledge are a core innovation process that needs requirements and plans to be done before firms start to innovate; Over the past decades, these closed innovation strategies have changed because many firms across industries now acquire a considerable volume of their technologies from external sources, Cohen and Levinthal⁸; Tsai and Wang⁹. The effect of innovation processes can provide benefit to the firms when they start testing their innovation process compared to other competitors in the market helping them to innovate based on the market needs.

Moreover, several papers discuss the issue of comparison of SMEs/ LMT firms in their country with other countries to find out the differences of the innovation levels between them. At this point, we compare the innovation processes in SMEs/ LMT firms in Catalonia with that of Open- Alps. We focus on external sources of knowledge and innovation level in the both cases. We investigate to find out where are Catalan SMEs/ LMT firms standing in comparison to other EU countries as well with respect to Open-Alps.

4.1. Literature Review

Historically, EU countries including Catalonia, Spain, has had a longstanding tradition of industrial innovation in SMEs/ LMT firms. Their policy tools have to be adapted to increase the innovation levels to regional standards and to achieve established goals. The main innovation policy in the industry place improves when there is an increase the research in the field of OI activities in their structure by starting to collaborate with external sources of knowledge from the perspective of OI activities. The companies need to collaborate with other external sources; the OI

proliferations call for not only the ideation within enterprises, but also requires a deep assessment of collaborators like academic, research practitioners and intermediaries with the collaboration and industry relationship, Saguy¹⁰.

Definition and implementation of OI model in the industry creates value and open ideas from both external and internal sources. This has shown a steady increase and are being used in the field of SMEs/ LMT firms and proposes an OI model where firms commercialize external (as well as internal) ideas by developing outside (as well as inside) pathways to the market, Chesbrough⁶. To describe OI concepts, we need to understand where Catalan firms stand among other firms, regionally or locally. OI activities are also described as innovative firms sustain and advance their current businesses and start up new businesses, Chesbrough,².

Consulting and cooperating with other firms to help companies develop strategies' not only to innovate, but also to increase their innovation processes outside their firms and get more information on how other firms improved their innovation levels. The innovation value-based relationships increase innovation outcome and helps increase the innovation levels between firms; previous research shows that a broader external environment provides firms with more information cues, Geletkanycz and Hambrick¹¹. More generally, in those firms, it is assumed that external sources of knowledge are important not only for radical innovations but also for LMT industry innovations, Faulkner¹².

To accomplish this, we explore the innovation models of EU countries and Catalonia when they start and choose to collaborate with each other? In our research, we observed a difference in their innovation levels, technological progress and average level of research input and output. From one firm to another firm in the same field and region, we would like to figure out the differences in the average level of research input and research output using OI strategies', external source and collaboration. This finding supports the idea of OI models, that differences between firms increase their innovation when they start to collaborate with each other. Differences in total factor of productivity account for roughly half the differences in income across countries and are generally associated with differences in technological progress, e.g. Hall and Jones¹³.

This paper provides more details on the differences between Open- Alps and Catalonia by focusing on top articles and journals in the field of SMEs/ LMT firms. The

major benefits is to understand where Catalan SMEs/ LMT firms stand in comparison with other EU countries, and what are the differences between them in the innovation process. In short, we explore the difference between Catalan SMEs/ LMT firms and Open- Alps in their innovation processes.

We try to find out the relationship between Open- Alps and Catalonia by a comparing between the two case studies in SMEs/ LMT firms. The advantages of this relationship are to carry out structural ideas and to ensure the benefit of this issue arising out in this article by analysing the linking points between them. The analysis of the links between innovative firms will be based on the concept of Systemic innovations, Maula et. al¹⁴. Many arguments suggest that SMEs/ LMT firms innovation level has become an important issue. We focus on this issue and analyse the benefit of external source of knowledge like UR, university research, R&D research and development, partner relationship activities and other nations.

Finally, we summarize the lessons learned from OI model, and present the two case studies. The differences between firms in the technological progress and processes are to improve innovation level in Catalonia compared to Open- Alps and other EU countries. Using external source of knowledge helps firm to link their innovation process with other firms and improve their OI model.

4.2. A case Study of Catalan ICT Sector and Open- Alps Platform

The purpose of this paper is to better understand OI concepts in Catalonia and EU countries. In order to do that, we conduct a survey and compare the results in two cases: 1) The technology sector in Catalonia, ICT and 2) The data analysis of Open-Alps. The key point of focus is to identify the difference on how firms collaborate with external source of knowledge in their innovation process. Detailed analyses of the case studies are as follows:

4.2.1. A case Study

The case studies are a descriptive statistic to refine the definition and explanation of the OI concept. The case is elaborated and illustrated with keywords such as OI concept, external source of knowledge and innovation level. Our two cases are based

on the experience of innovation activities in the field of SMEs / LMT firms. There was evidence to give a broader picture of the two cases and we have selected relevant items in the field of SMEs/ LMT firms: Catalonia and Open- Alps. The case study was used to analyse a descriptive statistic and to compares differences between the two cases to better understand the differences in the usage of OI concept between them. See Table 1.

Table1. A case Study: Catalan ICT sector and Open- Alps Platform.

ICT sector in Catalonia	OI platform in Open-Alps
Identify the technology sector in Catalonia.	Identify OI platform in Open-Alps.
Analyse the context: a snapshot of ICT sector in Catalonia.	Analyse the OI Platform’s needs for guiding the final OI method proposed.
A SWOT analysis of Catalan technology sector	A SWOT analysis of OI for Platform in Open Alps

Source: [Low /Medium Technology; LMT Firms in Catalonia and Open-Alps. Own Elaboration]

In Catalonia; the following section is devoted to the analysis of the technology sector, ICT and recent study that including identifying ICT sector and analysis the context of 2013 survey.

In Open-Alps; the following section is devoted to the data analysis of OI platform and recent study including identifying the SMEs / LMT firms in Open- Alps project and analysis the context of 2011 survey.

4.2.2. The Case Questions

We aim to draw the differences between Open- Alps and Catalonia in the fields of SMEs/ LMT firms. The discussion will be highlighting the weaknesses and strengths. However, to find out the relevance of OI concept, external source of knowledge and innovation level in Catalan and Open-Alps SMEs/ LMT firms, we compared a descriptive statistic to understand the industrial sector and used relevance policy and facilities data, to assist policy makers understand the impact of our study. Prior research has shown the importance of establishing a reputation as a knowledge provider in order to increase the monetary and strategic benefits of technology out-licensing, Lichtenthaler and Ernst¹⁵. However, identifying OI concept has been

empirically used in the field. To develop the concepts of OI and external sources of knowledge as complement between two different approaches and focus on the innovation related activities in Catalan and Open-Alps SMEs/ LMT firms. We found that firms who are using different external knowledge sources are more successfully; this is why linkages to different external knowledge sources tend to co-exist, see in particular Roper *et al.*,¹⁶. We divide the article into two sections as follow:

First section, we discuss the main characteristics of the study and the relevant points of OI concept, external source of knowledge and innovation level in the field of the study. In this section, we identify the missing points of Catalan and Open-Alps SMEs/ LMT firms and answer the first question: Are the use of external source of knowledge in Catalonia and Open-Alps related to OI concept activities?

Second section, we discuss key findings of using of OI concept related activities in Catalonia and Open- Alps and the relevant points of OI concept, external source of knowledge and innovation level in the field of study. In this section, we identify the missing points of Catalan and Open-Alps SMEs/ LMT firms and answer the second question: How do Catalan and Open- Alps SMEs/ LMT firms identify useful external source of knowledge in their firms?

4.2.3. Open Innovation Related Activities in Catalan, SMEs/ LMT Firms

Catalonia is a region of Spain. We investigate on how companies acquire innovation from their external source of knowledge. To understand the advantage of OI concept, we build a structure of external source of knowledge in SMEs/ LMT firms' field by comparing the field with the innovation structure of external source of knowledge in Open-Alps. The OI concept captures the increasing need to use external source of knowledge as the source of innovation and still facing some struggle in several industrial sector. SMEs are struggling with its implementation due to their relatively low level of absorptive capacity, policy and financial constraints, and perceived management challenges, Van de Vrande et al.¹⁷ ; Saguy¹⁸.

Taking into account Catalan industry continues innovating in SMEs/ LMT firms, industrial sector, we look into the differences in industrial situation between Catalonia and different EU countries. This is important to analyse the differences between them and find out the weakness and strengths in the field of Catalan SMEs/ LMT firms. It is

established that LMT industries have an advantage in pursuing other innovative activities, Hansen and Serin¹⁹. In addition, all regional governments are interested in designing their own innovation policies primarily due to the considerable importance of innovation in the economic transformation and stimulation of regional development, Fritsch and Stephan,²⁰. Innovation activities in comparison similar case from different perspective and according to Valls et al.²¹, This is a view specially focused on technology innovation that allows for slight differences depending on whether it is related to SMEs or more or less technology-intensive industries.

Still there are many issues in the field that needs to be highlighted on the Catalan innovation level in the field of SMEs/ LMT firms and their use of external source of knowledge. In Catalonia, while in manufacturing sector, the share of innovative firms is high with permanent R&D activities that rise with firm size in (both high and low-tech), the reverse is true in service industries, Segarra-Blasco,²². Catalonia is focused on recruiting international talent to fuel its knowledge and innovation intensive strategy. The strategy is most visible in the number of science Parks that have been developed throughout the region, attached to universities or as part of a broader industry/city/university consortium, OECD²³.

4.2.4. Open Innovation Related Activities in Open- Alps, SMEs/ LMT Firms

Open-Alps are part of the EU's Alpine Programme and are co-funded by the European Regional Development Fund (ERDF) and the participating states. The project has duration of three years (July 2011 - June 2014). They offer a solution for SMEs/ LMT firms, from the perspective of OI model and their external source of knowledge and they ask firms to request collaboration with them as an external source of knowledge for the firms.

We analyse OI model and external source of knowledge from the Open-Alps perspective. They offer collaboration to each firm and help firms to analyse their relationship with their external source in the field of SMEs/ LMT firms. In the context of OI concept, the key find of Open-Alps is to increase innovation with both the breadth and depth of external search to help firms to innovate through there external source and opens their firms. Collaborating with external source leads firms to successfully increase their innovation levels. Most of the successful OI entrepreneurs are collaborating with external partners, suppliers, customers, universities or external

R&D activities. This helps firms to increasingly embrace open innovation, i.e. collaborating with external partners, including suppliers, customers or universities, to keep ahead of the game and get bring products or services to market before their competitors, OECD, ²⁴. In fact, breakthrough innovator companies were only 27% of the entire sample, but they were more interested in the OI platform as well as in collaboration projects for knowledge sharing, ²⁵

4.3. Main Characteristic of the Study

The main characteristic of the study are to focus on OI concept and how external source of knowledge contribute to develop firms innovation ability. We provide the current situation and the problems that SMEs/ LMT firms face to reveal an understanding for the case by identifying: 1) How do SMEs/ LMT firms innovate in Catalonia and Open-Alps and 2) Is OI concept considered an important player in the field of SMEs/ LMT firms in Catalonia and Open -Alps. Data is a descriptive statistic to clarify an argument of Catalan and Open- Alps in the field of SMEs/ LMT firms, industrial sector. We attempts to understand what happened in the field. Our two main aims: First aim is to identify ICT sector in Catalonia. The second aim is to identify OI platform in Open-Alps. In both the cases, we aim to understand and focus on the uses of OI concept and external sources of knowledge. Our descriptive statistic data provides observations of SMEs/ LMT firms in Catalonia and Open- Alps. We sample data from 2011 to 2013, and our data analysis is concerned with the Catalan and Open-Alps SMEs/ LMT firms, to describe and illustrate the differences between them in the field. These are characterized by the following attributes:

- Which of the cases use OI concept, external sources of knowledge and innovation activities in their firms?
- The strength and weaknesses, threats and opportunities that SMEs/ LMT firms face in the both cases.

4.3.1. The Case of Open-Alps Platform

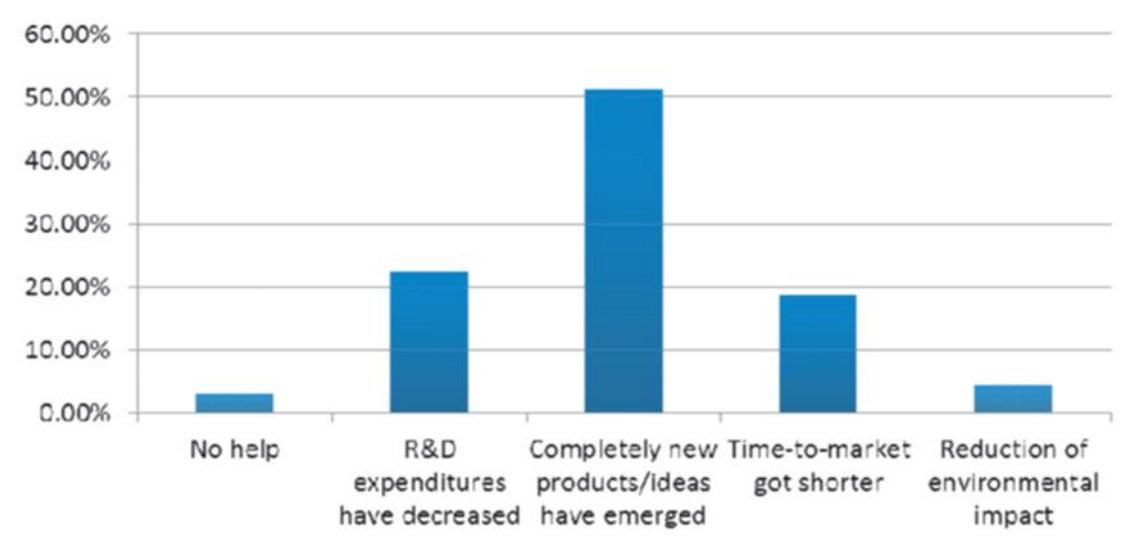
The aim of the questionnaire was to identify the OI Platform's needs for guiding final OI method proposed. The idea of the questionnaire as a method of analysis was

introduced to have a standard set of questions for a comprehensive investigation in all the regions involved in the project. We are presenting a selection of descriptive data from the case of Open-Alps. We are presenting a selection of descriptive data from the case of Open-Alps Platform as shown in result1 and 2.

Using OI concept, external sources of knowledge and innovation activities in their firms

As shown in result.1, we are presenting Figure1 and Figure2, on how the usage of external knowledge has helped Open-Alps to improve their efficiency. We have investigated the partners and the stages of collaboration for these companies. In particular, the partners chosen have been universities and Research centres, government bodies and agencies, customers, suppliers, competitors and consultants of collaboration. We have tried to identify the following: idea generation, technology development and experimentation, development, manufacturing system/process development. See Figure1.

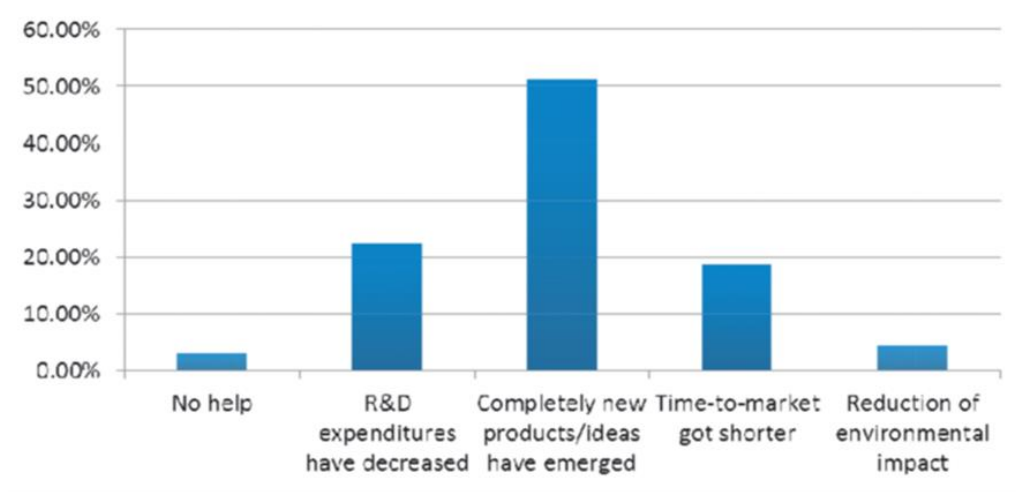
Figure1, Partner.



Source: [Figure1 Partner, Survey Data Analysis, ²⁵.]

Illustrates that the use of external knowledge that has helped the company for the emergence of completely new products and ideas (51%). This is followed by a decrease in R&D expenditures (22%) and in time-to-market (19%). See Figure2.

Figure2. The Use of External knowledge helped Your Company.



Source: [The Use of External knowledge, Survey Data Analysis, 25.

The weaknesses and the strength that SMEs/ LMT firms facing in the case of Open-Alps

As shown in result 2, the main strengths of the platform are identifiable in the focus on innovator companies, a range of services and facilities provided to Alpine SMEs platform participants, with specific attention to the education and management phase. Main weaknesses another weakness is linked to the scarce knowledge of the OI concept. Many are the potential opportunities of the OI platform but there are also many threats the former highlight the potentialities offered by the internet technologies, that enable to build strong networking activities and knowledge sharing between the Alpine SMEs involved in the project, a strong involvement of the regional partners involved in the Alpine SMEs project an ecosystem. See Table 2.

Table2. Swot Analysis of Open-Alps

Strengths		Weaknesses	
Focus on breakthrough innovator Companies		Little trust in the system	
Specific services and facilities for		Lack of time	
Alpine SMEs		Scarce knowledge of the OI concept	
Education management			
Opportunities		Threats	
ICT technologies		Competitors	
Deep involvement of regional		Absence of interest in new potential participants	
project partners and intermediaries		Little interaction and collaboration among the SMEs participants	
Networking and knowledge sharing activities, Alpine SMEs OI ecosystem rising			

Source: [Swot analysis of Open Alps, Survey Data Analysis, ²⁵.]

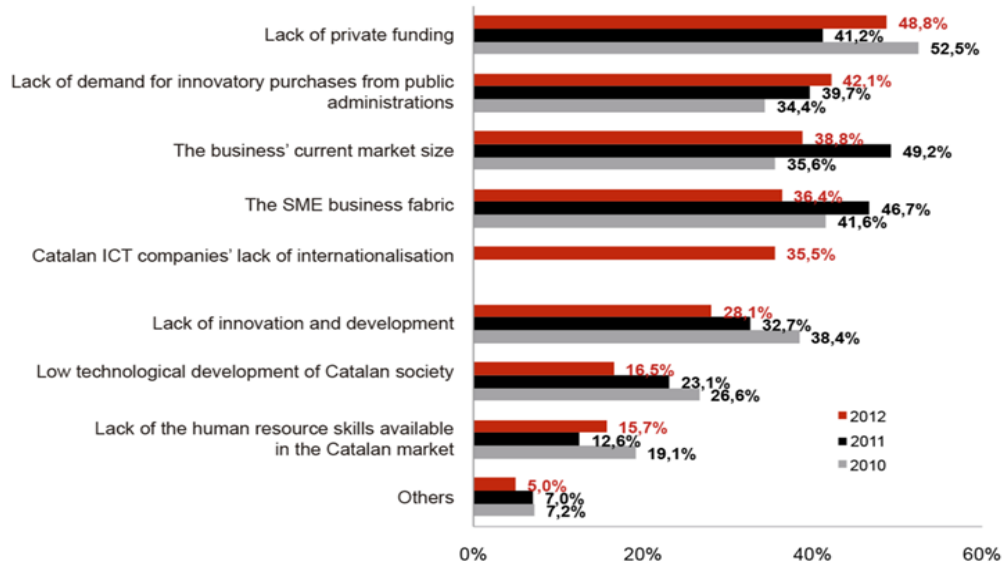
4.3.2. The Case of ICT Sector in Catalonia

The 2013 Survey of ICT sector gives a fairly bright picture, especially in the context of the economic crisis and continues the positive trend detected in 2012. In 2013, the sector gave a score of 6.1 out of ten in the survey's business section — a big improvement over its score of 4.7 in 2008. Moreover, Catalan ICT firms see themselves as competitive, scoring 7.2, only two decimal points below the figure for 2011. ²⁶ We are presenting a selection of descriptive data from the case of ICT sector in Catalonia as shown in result3 and 4.

Using OI concept, external sources of knowledge and innovation activities in their firms

As shown in result 3, we are presenting Figure 3 and Figure 4, on responses of Catalan firms on their concerns that were putting brakes in the technology sector and the recent trends in R&D spending. The lack of private funding is currently one of the sector's main concerns and was mentioned by almost half of the firms answering the survey. Other factors firms saw as putting a brake on development were: 1) Lack of innovative purchases by public administration (mentioned by roughly 40% of firms in both 2011 and 2012); 2) The current size of the market; Catalonia's business structure. See Figure 3.

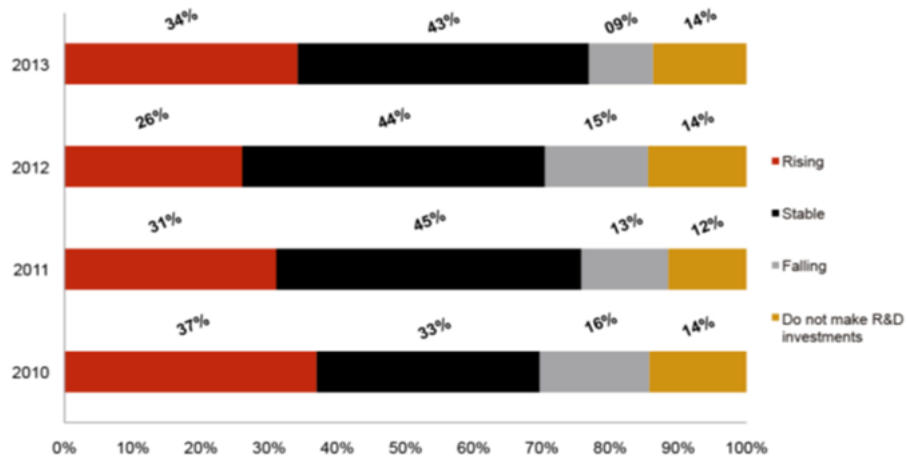
Figure 3. Brakes on The Technology Sector, 2010 – 2012



Source: [CTecno – Penteo, ²⁶]

While most companies say they have maintained their R&D spending, the scoring of their R&D investments have fallen to 5.4 in 2012 (down from 5.9 in 2011). This largely reflects the increase in the number of companies that do not carry out R&D and in those forecasting a cut in their research investment. A change in this trend in 2013 is envisaged, with (i) a marked rise in the number of firms forecasting greater R&D spending; (ii) a drop in the number of companies forecasting less research (both figures in comparison with 2012). ²¹ See Figure 4.

Figure4. Technology Trends and R&D



Source: [CTecno – Penteo, ²⁶]

The weaknesses and the strength that SMEs/ LMT firms facing in the case of Open-Alps

As shown in result4, the main weaknesses, as in 2011, technology transfer continues to be one of the sector’s main concerns. The gap between companies and universities remains despite efforts to narrow it and SMEs still have little contact with the academic world. The main strengths are a noted improvement in the company-university relations. The gap between universities and companies is narrowing, especially in the case of large companies. While SMEs still lag behind in this respect, a growing number of firms use universities as external R&D departments. Main threats are that SMEs are left out in the cold by the technology transfer System. The Main Opportunities that clear is the number of large companies giving support to help internationalise SMEs 21. See Table 3.

Table3. SWOT Analysis of Catalan Technology Sector, ICT.

WEAKNESSES	STRENGTHS
Lack of large firms	Positioning of the ICT sector in Catalonia
The sector has little influence	Potential allure of Catalonia: the Barcelona Brand
Localism and size	Catalonia’s research capabilities
Obstacles to internationalisation	Internationally-renowned assets
Technology transfer	University setting to boost business knowledge
Falling salaries	High employment rate in the sector
Technology carries little professional prestige	Talent
Falling prices	Competitive companies
Wrong focus in foreign markets	Flexibility in coping with the crisis
Other, such as the sector ’s poor structuring or lack of attention to patents	Improved company-university relations
THREATS	OPPORTUNITIES
Labour legislation hinders innovation	World-class sectors
Ability to exploit the opportunities offered by MWC	Expectations of MWC are being met and built upon
Lack of funding to fuel growth	Impetus to the forging of alliances
‘Brain drain’ in the sector	Changes of paradigm
ICT becoming a commodity	Cross-cutting nature of ICT
Persistence of the crisis	Availability of funding in certain fields
Loss of positions in strategic sectors such as Health	Catalonia’s long industrial track record
Little business positioning of ICT	Catalan know-how highly rated abroad
The crisis’ impact on research	Global economy
Others, such as late/non-payment by Public administrations	Others, such as the greater regard agents in the sector have for alliances and the support given by large companies for the internationalisation of SMEs

Source: [CTecno – Penteo, ²⁶]

4.3.3. Perspective of Missing Point: Are the use of external source of knowledge in Catalonia and Open-Alps related to OI concept activities?

The missing points are to justify the differences between our two cases and have point of implication for policy makers, and to give our perspective on innovation level claims to be able to identify and use this as an indicator of policy implications, the need of tools to innovate in the fields of SMEs/ LMT Firms. The following are:

The first case of Open-Alps that tested the field SMEs/ LMT Firms obtain evidence of using OI concept. We found out at the first place of idea generation was from the customer and then university and research centres, while government bodies and agencies does not have a high influences on innovation level. At the second place, we analyse whether the use of external source of knowledge helps the firms. We have observed a higher innovation levels through completely new products ideas with a decrease in R&D expenditures. At the third place, the main strength of the Open-Alps platform is the focus on the use of OI concept and its external source of knowledge and innovator companies. The weakness is linked to scarce knowledge of OI concept. We have also observed that there could be a much greater distance from application in case of knowledge transfers from scientific research institutes, Link et al.,²⁷. Siegel,²⁸.

The second case of ICT sector in Catalonia in the field of SMEs / LMT Firms did not show evidence of using OI concept. We found out at the first place, the lack of private funding is currently one of main concerns of the sector followed by the lack of innovative purchases by public sector administration. At the second place, the lack of concern or focus on OI concept, a standoff concentration on R&D spends and investment and the drop in the forecast of the companies' R&D spending. At the third place, the main weakness is the gap that remains between companies and the universities despite effort to narrowing this gap. SMEs still have little contact with the academic world. The main strength is to improve the companies' relationship with universities and to increase spending on R&D activities. In LMT industries, the main platform for innovation processes is not technological knowledge, but creativity and innovation-enabling capabilities, which are related to the abilities required to identify and assimilate the potentially relevant knowledge and translate it to fit the specific conditions of the firm, Bender and Laestadius²⁹. Universities and research centres engaging in a process of 'thinking along', Berends et al.³⁰.

The lesson that has been learnt from the differences of the two cases that SMEs / LMT firms, industrial sector, refer to Catalan case and its relationships with external R&D activities as well as UR activities as external knowledge can be helpful to increase the innovation level. Cooperation is usually characterised by the external source of knowledge from firms that will help firms to capture and integrate innovation, infer structures with different type of external source of knowledge, and use OI concept that will be contribute to the development process of the firms in Catalonia. We notice that Open-Alps started to analysis the SMEs/ LMT firms from the perspective of OI concept, while Catalan SMEs/ LMT firms in ICT sector still face some challenges in the field and doesn't analyse the field from the perspective of OI concept. Also Open-Alps start to analyse the use of external source of knowledge in SMEs/ LMT firms from the perspective of OI concept, while Catalonia start to analyse R&D activities and other external activities but not from the perspective of OI concept.

Finally, we will also consider that our study reflects a significant positives and negatives in the difference in innovation level between Catalan case and Open-Alps case. This helps policy makers to better understand the current situation in the field of SMEs / LMT Firms, industrial sector in Catalonia and the importance of OI concept and the external source of knowledge in the field.

4.4. Key Findings of Using of OI Concept Related Activities in Catalonia and Open- Alps SMEs/ LMT Firms

The present paper was intended to clarify key findings and implications for SMEs/ LMT firms, industrial sector. How these behavioural differences influence the innovation level of Catalan and Open-Alps SMEs/ LMT firms? To identify the effect of OI concept and external source of knowledge on the innovation level of Catalan and Open- Alps SMEs / LMT firms. Empirical findings suggest that this knowledge base is the main source of knowledge generation for LMT Companies, Robertson and Patel, ³¹. Innovation has been pointed out to have a significant influence in the field of SMEs/ LMT firms, industrial sector. Consequently, external source of knowledge was chosen as the topic of different SMEs/ LMT firms in EU countries. Many SMEs/ LMT firms were developed to work with OI concepts in the last few years. Revision of SMEs/ LMT firms from the first point of view reflects the innovation level character. However, there is

still a lot of missing points that firm's needs to learn and practice in the innovation fields. As Hirsch-Kreinsen et al., notes, there are low-tech industries which have survived and grown simply because codified knowledge that is compensated for by high-grade design skills and learning by doing³².

4.4.1. Key Finding on Catalan SMEs/ LMT Firms

The key finding of Catalan case, the main aim is to focus on SMEs/ LMT firms, industrial sector and its innovation level. Nevertheless there are signs that the relations between OI concept and SMEs/ LMT firms are facing some challenges that need to be strengthened. Their external source of knowledge has to be used from different perspectives to increase innovation level of SMEs/ LMT firms. Catalonia has reached one of the main goals of OI concept such as, R&D and UR activities in driving innovation process to provide benefit to its main point of using their external source of knowledge in the field of SMEs/ LMT firms, industrial sector.

We take into account the comparison of the differences between innovation levels that have introduced new improved to the field of SMEs/ LMT firms between Open-Alps and Catalonia. We selected Open-Alps case as EU countries approach that have introduced new improved and importance to their SMEs/ LMT firms. They start to adapt OI concept and external source of knowledge in their innovation process to the field of SMEs/ LMT firms, industrial sector. We focus on external source of knowledge and adopting OI concept to increase the innovation level of the SMEs/ LMT firms, in order to acquire types of information for policy makers, which can be integrated at different stages of improve and increase the innovation level of SMEs/ LMT firms in Catalonia, OECD,³³. Note that, Catalonia developed its own system of Catalan Research Centres, a unique strategy in Spain, building a strong research infrastructure in the region. However, the continued proliferation of such centres poses critical mass problems, locks in budgets and de facto locks in the region's research priorities, In fact, the low intensity of ICT use by firms and the low presence of relationships of complementarity between digital innovation, organisational change and occupational training have become a major limiting factor on firm productivity improvements in Spain, Torrent and Vilaseca,³⁴. See Table 4.

Table 4 . Open innovation relates external source of knowledge in Catalan, SMEs / LMT firms

External source of knowledge related to OI activities in Catalan, SMEs/ LMT firms Source	Source
Show that the rate of innovating SMEs having done a cooperation project in R&D and innovation in Catalonia was only symbolic, be it with customers (3.15%), suppliers (3.37%), competitors (3.77%) or consulting firms (2.77%). This formal cooperation rate was higher in the case of companies with more than 250 employees (17.5% with customers, 25.86% with suppliers, 22.52% with competitors and 16.12% with consulting firms).	Valls et al., ³⁵
In the field of Catalan, SMEs/ LMT firms, did not find a causal relationship between ICT investment and improvements in firm productivity in small and mediumsized firms, owing to the time lag between the digital enablement process and its.	Badescu and Garcés-Ayerbe, ³⁶
The low absorption capacity of firms, notably SMEs, limits their ability to adapt and absorb knowledge from universities, other tertiary education institutions and other research institutions.	OECD, ³⁷
There are insufficient incentives for university researchers to collaborate more intensively with private companies. This is because researchers' careers are solely linked to the publication of scholarly papers. Academic promotion should be linked to other things as well, such as patent filings, research applications, stimulating faculty involvement in business start-ups and projects. There is a general lack of entrepreneurial spirit and a legal framework in universities for fostering such measures. Universities must begin this transformation to foster links between academic research and the business world.	CTecno,, ²⁶

Source: [Open innovation relates external source of knowledge in Catalan, SMEs / LMT firms. Own Elaboration]

4.4.2. Key Finding on Open- Alps SMEs/ LMT Firms

Our finding on the contribution of Open-Alps to SMEs/ LMT firms, industrial sector is present on the concept of OI activities. We also infer that external source of knowledge and external ideas are the key to SMEs/ LMT firms to be able to innovate as well as other competitors in the market. The result confirms the finding of the innovation level and the ability of firms to be innovative and benefit from adaption of OI concept in their firms.

We found two important points in the Open-Alps case: First, the barriers to be afraid of the platform, meaning lack of technological knowledge as well as lack of skilled personnel. Second, they better understand the main expectations from the web-based OI Platform for Alpine SMEs for guiding the design and implementation of its major characteristics. At this point, they established a mission and continue to promote the OI concept in SMEs/ LMT firms, industrial sector. It also gives us as new set of tools and technologies to be implemented in their firms. See Table 5.

Table5. Open innovation relates external source of knowledge in Open-Alps, SMEs / LMT firms

External source of knowledge related to OI activities in Open-Alps, SMEs/ LMT firms	Source
In order to sustain the ability to introduce new products to the market successfully, many firms have shifted to a model of ‘open innovation’ that exploits the knowledge of a wide range of actors.	Chesbrough, ³⁸
There are evidences for the importance and validity of open innovation across many firms and contexts.	Huizingh, ³⁹
The most important variables identified in this factor are two specific risks and barriers to be afraid of the platform meaning lack of technological knowledge as well as lack of skilled personnel.	Open- Alps, ²⁵
This empirical analysis was useful for understanding better the main expectations from the web-based OI Platform for Alpine SMEs as well as for guiding the design and implementation of its major characteristics.	Open- Alps, ²⁵

Source: [Open innovation relates external source of knowledge in Open- Alps, SMEs / LMT firms. Own Elaboration]

4.4.3. Perspective of Missing Point: How do Catalan and Open- Alps SMEs/ LMT firms identify useful external source of knowledge in their firms?

We present the key findings introduced for two case studies: Catalan and Open-Alps, SMEs/ LMT firms. Our discussions of the missing points are as follows:

In Catalonia, Are the use of external source of knowledge related to OI concept activities?

Revision of the key finding in the case reflects the present character of the situation when it comes to external source of knowledge. The result shows that firms make an effort to innovate in different ways and use different source of knowledge to innovate. Empirical evidence shows that only small number of SMEs/ LMT firms use the OI concept. According to Valls et al.,²¹, there are few formal collaboration both from a customer and a supplier perspective. Also, according to OECD,^{34, 35} SMEs limit their ability to adapt and absorb knowledge from universities, other tertiary education institutions and other research institutions. R&D is declining because it is mainly financed out of cash flow which contracts in downturns. Finally according to CTecno,²⁶, there is a general lack of entrepreneurial spirit and a legal framework in universities for fostering such measures. Within this unstable innovation environment, it makes sense for firms to externalise their technological options and innovation opportunities through licensing to other businesses or by forming alliances and engaging in cooperative agreements rather than keeping options in stock and running the risk of never exploiting them, Chesbrough,³⁸

In Catalonia, How do SMEs/ LMT firms identify useful external source of knowledge?

Identification of the present situation shows that there are still challenges and difficulties facing the Catalan Case and the use of OI concepts and its external source of knowledge. The findings of the Catalan case are structured as follows:

- The weakness is the lack of use OI concept and external source of knowledge.
- The focus of university research and research still shows a limitation in the field.
- SMEs/ LMT firms limit their ability to produce output through external R&D activities.
- Collaboration with other external source of knowledge like customers, suppliers, competitors, government bodies and consultants, isn't deeply present in the case.

In Open- Alps, Are the use of external source of knowledge related to OI concept activities?

Revision of the key findings in the case reflects the present character of the situation when it comes to external source of knowledge. The result shows that firms make an effort to innovate in different ways and use different source of knowledge to innovate. Empirical evidence shows that in order to sustain the ability to introduce new products to the market successfully, many firms have shifted to a model of 'open innovation' that exploits the knowledge of a wide range of actors, Chesbrough, ³⁸. There are evidences for the importance and validity of open innovation across many firms and contexts, Huizingh, ³⁹. Add to all, this empirical analysis was useful for better understanding the main expectations from the web-based OI Platform for Alpine SMEs as well as for guiding the design and implementation of its major characteristics, Open-Alps, ²⁵. A successful innovation can be defined in many different ways and the key to a successful innovation tournament lies in the ability to extract the best few opportunities from a process that considers many factors, Terwiesch and Ulrich, ⁴⁰.

In Open- Alps, How do SMEs/ LMT firms identify useful external source of knowledge?

Identification of the present situation show that, still there is challenges and difficulties facing the Catalan Case, and the use of OI concept and its external source of knowledge, the finding of Catalan case are structured as follow:

- Weaknesses include lack of technological knowledge as well as lack of skilled personnel.
- The opportunities are the use of OI concept and its external source of knowledge.
- Understanding better the main expectations from the web-based OI Platform for Alpine SMEs.
- The use of external knowledge has helped firms to innovative. Suppliers and customers have the highest rate that has been used as external source for Open/ Alps case.

Finally, the difference of our two case studies shown above are based on a key finding from the selected data to help policy makers to find the differences between their case and other cases in the same field.

4.5. Concluding Remarks

In our paper, we justify the differences between the two cases to obtain empirical evidence in the use of OI concept and external source of knowledge. We found out that there is a need to improve a number of points in the fields, to achieve innovation from a region standard innovation level and where Catalan SMEs/ LMT firms stand among other firms. Also, how other firms improved their innovation level, and which type of innovation they carry out structural ideas and ensure the benefit in other SMEs/ LMT firms field. It is necessary to improve our understanding of the difference in innovation levels in the two cases and if they are related to OI concept and its usage of external sources of knowledge. As OI concept is being addressed in the case of Open- Alphas within the context of External source of knowledge, Catalan case is still facing challenges and struggles in the field of OI concept and its external source of knowledge. Catalonia also has a lot of opportunities in the fields of innovation and infrastructures in many fields. However, SMEs/ LMT firms still face some difficulties in their innovation process compared to the EU level, which need to be increased for the innovation output to be able to match regional and international competitors. Therefore, the important key of the open innovation model is how firms recognize, carry out and maintain knowledge and ideas from external sources in their innovation procedure, Raymond & St-Pierre, ⁴¹. How each of them relies on external source of knowledge in the innovation process of their SMEs/ LMT firms. Our articles rely on the following two Policy implications:

A. As policy implication and tool: Our explanation of Catalan case in the first and second section, policies have the potential to influence the innovation level depending on the aspects of improving the SMEs/ LMT firms fields. Empirical finding on ICT sector in Catalonia indicate that there is a need to increase investing in the R&D activities and UR activities. Our investigation shows that SMEs/ LMT firms are left out of the innovation process. There appears to be no empirical evidence to show that SMEs/ LMT firms use or adapt OI concept in the field of ICT sector in Catalonia. In the structure of innovation for the field, they depend mostly on R&D activities and UR activities. There still needs to be an increase in the average level of both sectors. We should note here that although the OECD classification is elaborated according to R&D ratios, R&D intensive firms occur in low tech sectors, and non-R&D intensive firms occur in high tech sectors, Kirner et al., ⁴²; Santamaria et al., ⁴³. In other words,

Catalonia has a long industrial history and has an infrastructure to start adapting their policies for the sector and investing more in the field of SMEs/ LMT firms, industries sector.

B. As policy implication and tool: Our explanation of Open-Alps case in the first and second section, policies have potential to influence the innovation level depending on the aspects of improvement in the SMEs/ LMT firms. Open- Alps sector, have started to adapt the OI concept in their research strategies. They are cooperating regionally to increase their innovation levels. To obtain external source of knowledge from their partners, they found out that there is a lack of knowledge on OI concept in there firms, but they invest and organize their research to improve and develop the sector of the SMEs/ LMT firms. External knowledge is a technological opportunity to improve innovation capacity and can be found in sources such as firm-university linkages or relationships with suppliers, customers, e.g. Klevatorick et al., ⁴⁴; Lee et al., ⁴⁵; Grimpe & Sofka, ⁴⁶ . Open- Alps is an EU project and is financed to increase innovation through cooperation and shared knowledge and to help firms innovate through Open-Alps research as an external source of knowledge.

4.6. References (Chapter 4)

- [1] M.E. Porter and S. Stern: Innovation: Location matters. *Sloan Management Review*, 2001, 28–43.
- [2] H. Chesbrough: *Open Business Models: How to Thrive in a New Innovation Landscape*. Harvard Business School Press, Boston, MA, 2006.
- [3] H. Chesbrough, A. K.Crowther: Beyond high tech: early adopters of open innovation in other industries. *R&D Management*, 2006, 229–236.
- [4] K.W. Glaister and R. J. Falshaw: Strategic planning: still going strong? *Long Range Planning*, 1999, 107–116.
- [5] E.V. Hippel: *The sources of innovation*. New York: oxford university press, 1988.
- [6] H. Chesbrough: *Open Innovation, The New Imperative for Creating and Profiting from, Technology Harvard University Press: Cambridge, MA. 2003*.
- [7] H. Chesbrough: The era of open innovation. *Sloan Management Review Summer*, 2003b, 35–41.
- [8] W.M Cohen and D.A. Levinthal: Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 1990, 128–152.
- [9] K.H. Tsai and J.C. Wang: External technology acquisition and firm performance: a longitudinal study. *Journal of Business Venturing*, 2008, 91–112.
- [10] S. I. Saguy: Academia-industry innovation interaction: Paradigm shifts and avenues for the future. *Procedia Food Science*, 2011, 1875 – 1882.
- [11] MA. Geletkanycz, DC Hambrick: The external ties of top executives: implications for strategic choice and performance. *Admin Sci Q*, 1997, 42:654–81.
- [12] W. Faulkner: Conceptualizing knowledge used in innovation: a second look at the science-technology distinction and industrial innovation. *Science, Technology & Human Values* , 1994, 425–458.
- [13] E. Hall, Robert and I. Charles Jones: Why Do Some Countries Produce So Much More Output Per Worker Than Others? *Quarterly Journal of Economics*, 1999, 83-116.
- [14] M. V. J., Maula, T. Keil & J.-P Salmenkaita: Open innovation in systemic innovation contexts. In H. Chesbrough, W. Vanhaverbeke & J. West (Eds.), *Open Innovation:*

- Researching a New Paradigm Oxford & New York: Oxford University Press, 2006, 241-257.
- [15] U. Lichtenthaler and H. Ernst: Developing reputation to overcome the imperfections in the markets of knowledge. *Research Policy*, 2007, 37- 55.
- [16] S. Roper, J. Du & J. H. Love: Modelling the innovation value chain. *Research Policy*, 2008, 961-977.
- [17] V. Van de Vrande, J. P. J. de Jong., W. Vanhaverbeke, & M. de Rochemont, M: Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 2009, 423-437.
- [18] S. I. Saguy: Academia-industry innovation interaction: Paradigm shifts and avenues for the future. *Procedia Food Science*, 2011, 1875 – 1882.
- [19] P. Hansen, G. Serin: Will low technology products disappear? The hidden innovation processes in low technology industries. *Technological Forecasting and Social Change*, 1997, 55, 179–191.
- [20] M. Fritsch & A. Stephan: Regionalization of innovation policy-Introduction to the special issue. *Research Policy*, 2005, 1123–1127.
- [21] J. Valls Pasola: Business relations and external players in the innovation process. *Paradigmes*, 2008.
- [22] A. Segarra-Blasco: Innovation and productivity in manufacturing and service firms in Catalonia: a regional approach, *Economics of Innovation and New Technology*, 2010, pp.233-258.
- [23] OECD, Higher education in regional and city development. The autonomous region of Catalonia, Spain. Paris: *OECD Publishing*, 2010.
- [24] OECD, Open Innovation in Global Networks. Paris: *OECD Publishing*, 2008.
- [25] Open- Alps: Survey Data Analysis, *Politecnico di Torino Piedmont – Italy*, Open Alpa, 5-3-1 D.
- [26] CTecno: The Technology Sector in Catalonia, Pento, Co-ordinated and supervised by CTecnos organization and procedures section, *CTecno Publishing*, 2013.
- [27] A.N. Link, D.S. Siegel, B. Bozeman: An empirical analysis of the propensity of academics to engage in informal university technology Transfer. 2006, *Available SSRN: <http://ssrn.com/abstract=902207>*.

- [28] D. S. Siegel: Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management*, 2004, 115–142.
- [29] G. Bender, S. Laestadius: Non-science based innovativeness: on capabilities relevant to generate profitable novelty. In: Bender, G., Jacobson, D., Robertson, P.L. (Eds.), *Non-Research-Intensive Industries in the Knowledge Economy. Journal for Perspectives on Economic Political and Social Integration*, 2005, 123–170.
- [30] H. Berends, R. Garud, K. Debackere and M. Weggeman: Thinking along: crossing boundaries in knowledge work, *International Journal of Technology Management*, 2011, 69–88.
- [31] P.L. Robertson and P. Patel: ‘New wine in old bottles: Technological diffusion in developed economies’, *Research Policy*, 2007, 36, 708–721.
- [32] H. Hirsch-Kreinsen, D. Jacobson, S. Laestadius and S. Keith: Low-tech industries and the knowledge economy: state of the art and research challenges, *STEP REPORT*, 2003, SINTEF.
- [33] OECD, *Policy Responses to the Economic Crisis: Investing in Innovation for Long-Term Growth*, OECD, Paris, 2009.
- [34] J. Torrent & J. Vilaseca: *La empresa red. Tecnologías de la información y la comunicación, productividad y competitividad*, Ariel, Barcelona, 2008.
- [35] J. VALLS, N. MANCEBO et al: Innovacions organitzatives i competitivitat industrial”. In: *Papers d’Economia Industrial*, 20. Departament d’Indústria, Generalitat de Catalunya, Barcelona, 2004.
- [36] M. Badescu & C. Garcés-Ayerbe: “The impact of information technologies on firm productivity: Empirical evidence from Spain”, *Technovation*, 2009, 122-129.
- [37] OECD, *Review of regional innovation, Catalonia, Spain*, OECD Publishing, 2010.
- [38] Chesbrough, H.W., 2003. *Open Innovation—The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press, Boston.
- [39] E. K. Huizingh: *Open Innovation: State of the Art and Future Perspectives*. *Technovation*, 2011, 31, 2-9.

- [40] C. TERWIESCH and K. T. ULRICH: Innovation Tournaments: Creating and Selecting Exceptional Opportunities. *Harvard Business School Press*, 2009.
- [41] L. Raymond & J. St-Pierre: R&D as a determinant of innovation in manufacturing SMEs: An attempt at empirical clarification. *Technovation*, 2010, 48–56.
- [42] E. Kirner, S. Kinkel, A. Jaeger: Innovation paths and the innovation performance of low-technology firms-An empirical analysis of German industry. *Research Policy*, 2009, 447-458.
- [43] L. Santamaria, MJ. Nieto, A. Barge-Gil: Beyond formal R&D: Taking advantage of other sources of innovation in low-and medium-technology industries. *Research Policy*, 2009, 507-517.
- [44] A. Klevorick, R. Levin. R. Nelson, S. Winter: On the sources of significance of inter-industry differences in technological opportunities, *Research Policy*, 1995, 185-205.
- [45] Ch. Lee, K. Lee, and J. Pennings: Internal capabilities, external networks, and performance: a study on technology-based Ventures, *Strategic Management Journal*, 2001, 615–640.
- [46] C. Grimpe, W. Sofka: Search patterns and absorptive capacity: Low- and high-technology sectors in European countries. *Research Policy*, 2009.

Chapter 5
Conclusions

The Research Scope

This research analyzes open innovation, (OI) and innovation processes in Catalan firms and compares it with that in other EU countries through various frameworks from reference materials. The analysis provides recommendations for policy makers to implement and to increase the innovation activities in Catalan SMEs/ LMT firms and stresses on implementing OI concepts in the sector.

We describe the present findings and future direction from a structured review of SMEs, LMT that is relevant to firms and industries in Catalonia. We review the literature to understand the structure of Catalan industries model and the effectiveness of OI model. We compiled the relevant outcome of the research structures in terms of different themes such as OI activities, R&D, UR and external source of knowledge literature to study their effect on the firms in Catalonia who are striving to develop innovation in the region.

We discuss the current finding and future direction of SMEs/ LMT firms, industrial sector in Catalonia. To enhance definition of “Open innovation, Technological Change, Industrial Innovation and Industrial Policies” in the field, we focus on SMEs/ LMT firms to provide a structured approach for Catalan case.

We considered examples from the history of SMEs, LMT firms in Catalonia in order to structure a result of current needs to be developed in the future. The first part focuses on an introduction to data structures, defining these data structures from previous literature and descriptive statistics. We introduce and review items of previous research in the area which indicate the structure and result of our research chapters as follows:

Current Finding of Catalan SMEs/ LMT Firms, Industries Sector

We found that innovation has a significant impact on economic growth. Several recent studies show that Catalan SMEs/ LMT firms have been active in innovation processes. The structure of Catalan framework has been changing and new industries are being created through innovation presently. The innovation factor has aided the growth of the Catalan industry.

However, there are several challenges that Catalan firms are facing with the current economic situation. Research findings on Catalan SMEs/ LMT firms industry and

outcomes suggest that SMEs/ LMT firms still need to improve their innovation process to reach the innovation levels in several EU countries.

The structure of innovation in Catalonia faces some critical points at the current time. First, the current economic crisis, market needs and competitors from international industry in Catalonia have an effect on the current situation of the field. Second, implementing OI activities are important to develop the innovation process, but at the same time, the ability of the firms to raise their innovation level in many areas and challenges to finance their innovation process and projects. Finally, the government's help in the field are limited to them. The current findings on industrial in SMEs/ LMT firms are as follows:

Structured Review of the Result on Catalan SMEs/ LMT Firms, Industries Sector

It seems necessary to conduct research and the outcome of it will help Policy-makers to manage the change of the situation in terms of such measures as Present findings. We indicate that OI activities and R&D activities help firms to innovate not only adapting new knowledge from the academic fields to help firms, but also policy decisions that could help more in changing and increasing the innovation activities. There is evidence for effectiveness on policy implications for Catalan SMEs and LMT firms. We establish research that explains the use and the importance of OI in firms and found out that in addition to the elements that firms need at the current time, there is also a serious need of help from policy makers to these firms who are struggling due to the current economic situation.

The purpose of the research result provides the current situation on the innovation activities and process and the use of OI activities, R&D activities, UR activities and external source of knowledge and innovation level. Our research refers to different findings and concepts, the linking between academic world and firms, policy change, increasing the innovation level and increasing financing for innovation activities in firms, including:

- 1) Our research design literature result depends on selected articles from OI activities and Catalan SMEs/ LMT firms cited in the field of innovation and technology in the industrial sector.

2) We use a descriptive statistic as an indicator of SMEs/ LMT firms in order to examine our research questions and hypothesis. Our descriptive statistics is derived from several resources. We sample data in chapter two from, 2008 to 2010, in chapter three from 2008 to 2012 and in chapter four from 2011 to 2013.

3) The results of the research establish a relationship between different themes and OI activities in Catalan SMEs/ LMT firms and as we have previously reviewed in the literature, the effectiveness and efficiency of OI activities, the implementation process of OI activities and the use of external source of knowledge in SMEs/ LMT firms. We use this research to compare the innovation activities of Catalonia and Several EU countries firms.

Catalan SMEs/ LMT Firms and Industries

The present findings allow us to describe the current need of Catalan firms. We found out that a positive effect to the economy to help SMEs/ LMT firms to higher their innovation levels and to be able to face International market in their country, we can't deny that Catalonia has thrived out of SMEs/ LMT firms, industrial sector. The decision has to be taken from policy makers in this field to improve the average innovation levels. We found that Catalan innovation level is lower than innovation level in the region in many issue as well as R&D activities, UR activities and the use of external source of knowledge. It will be difficult for firms to develop this alone and will need help through policy decisions. This can change the economic situation if they start to focus on changing the current situation through different perspectives in the field.

In our research, we describe data result in the fields of SMEs/ LMT firms on OI, R&D, UR activities, the use of external source of knowledge and the innovation level as indicators for Catalan policy makers. Our research presents data from Catalan SMEs/ LMT firms and industries including:

The analyses of the use of OI activities and innovation average level, innovation process in Catalonia shows impressive improvement at different levels, but the performance of SMEs/ LMT firms in Catalonia and their innovation processes still faces challenges in the structure of linking between R&D, UR activities and firms.

The research encourages policy makers to take decision to focus on innovation activities with regard to the SMEs/ LMT firms, industries sector in Catalonia. We should note here that although the OECD classification is elaborated according to the needs of increase in the average innovation level of SMEs/ LMT sector in several EU countries. We suggest that further links be established and expanded between firms and R&D and UR activities will helps firms in their innovation process which still face challenges in the coordination and implementation of OI and the development of different strategies to be applied in SMEs/ LMT firms in Catalonia. We found that innovation process takes place at different levels in a firm when we investigated in Catalan SMEs/ LMT firms. We responded to the need to understanding this sector on how Catalan firms can implement OI activities by comparison to firms in other EU countries.

We emphasize that there are many other tools to understand before one can start to implement OI activities. One of these tools is to increase the average level of innovation activities, R&D and UR outcomes in industrial sector and especially SMEs/ LMT firms. Catalonia has many opportunities of innovation infrastructures in many fields. However, SMEs/ LMT firms still face some difficulties in their innovation process compared to the EU average level, which need to be increased for the innovation output to be able to match regional and international competitors

The Future of Catalan SMEs/ LMT Firms and Industries

In the near future, there is a need for a movement from policy makers toward the sustainability of SMEs, LMT, and the industrial sector. Future direction of the framework of Catalan Industrial, SMEs/ LMT firms, to increase the level of innovation and use OI activities are important to sponsor industry and firms. The evidence shows that future industrial sector approaches need to provide a sustainable environment. The benefits of such strategies need to be evaluated from policy makers who are responsible for sustaining the Catalan Industry which has long developed industry requirements.

Future Directions of our research are based on OI approach and the field of SMEs/ LMT firms in Catalonia. We indicate the issues that Catalan firms are facing to provide directions for future research and policy makers. Our goals are the following:

- 1) We provide evidence that helps in policy changes which we have identified in the research that Catalan firms recognise the difficulties they face in their innovation

process and the effect of economic crisis, local and regional competitors and policy maker decisions.

2) We provide evidence that the needs of firms to be able to develop their innovation process in the future are: Increasing spends on R&D activities, UR activities and the implement of OI activities tool in their firms that needs attention from both firms' owner and policy makers in the government of Catalonia.

3) We provide a comparison between the innovation levels of Catalan and several EU countries firms in the field of SMEs/ LMT firms, industrial sector. We found out there is a gap between them that needs to be filled to help the development process of the firms.

4) We ensure that Catalan firms do recognise that they are part of EU countries and a dynamic industry always faces challenges in the open market. In achieving this, challenging the Catalan firms need a sustainable plan that will play an important part in the innovation process of Catalan SMEs/ LMT firm's future. Catalonia has entered an innovation process and agreements to sustain their SMEs/ LMT firms' field, but there still is a need to understand the challenges and opportunities that they face, nationally, regionally and in there developments process, they need to establish a sustainable plan for the field.

In conclusion, our recommendations for future researchers indicate the needs of firms in their development process. Our results found there is a need to increase spends on innovation, R&D and UR activities in the field and the link between SMEs/ LMT firms and the outcomes of innovation activities. Furthermore, policy changes will affect the innovation process of SMEs/ LMT firms, through new policies considering the previous points which policy makers are able to make or change in the future of SMEs/ LMT firms.

Our research presents the results are to improve the innovation process of SMEs/ LMT firms. We found out that the increasing use of OI tool such as the external source of knowledge will provide firms with new knowledge. The link between innovation outcomes and SMEs/ LMT firms will help firms to improve their innovation levels and ensure that they need to increase their spending on their innovation activities. A significant focus on innovation skills such as OI activities will help firms to have

sustainable benefits in the future. Innovation level providers highlight the important role that firms have in contributing to the development process by comparing their firms innovation level with others in the same region, which they operate in how they will create a sustainable growth for their firms, to reduce the policy decision, to increase investing in innovation activities and gives more attention to the field of SMEs/ LMT firms in Catalonia.

The result provides a challenge for reforming policy decisions on increasing investment in the field of innovation for SMEs/ LMT firms in Catalonia. The Strategy for Sustainable Growth needs to increase and improve the innovation activities. This opportunity to obtain essential innovation level and Catalan firms to be able to compete in the current market, innovation activities is an important driver of SMEs/ LMT firms in several EU countries and Catalonia.

Further founded on Catalan SMEs/ LMT firms, flexible structure will help firms to innovate and support the needs of increase in the innovation levels and invest more on research to change policies. Also create stronger links between academic world and Catalan SMEs/ LMT firms to help firms to take action by obtaining new knowledge by increasing spend on innovation activities. It is essential that innovation activities gain when firms invest in the innovation process in Catalan case and the reduction in innovation needs to be analysed deeply.

Therefore, the key finding of the research is to build a map of needs in the innovation process of Catalan firms. We identified the needs of innovation activities that need to be adapted from firms in their innovation process. We identify the current needs of Catalan firms as follows:

1) The innovation process needs are to a) Establish a strong relationship between academic world and firms, b) Increase spending on R&D activities, c) build bridges between firms in the region of EU countries and Catalonia 4) Increase the innovation level of SMEs/ LMT firms compared to EU countries average level. d) Increase the cooperation of R&D, UR activities and firms. In short, the cooperation levels between various centres has to be increased to put shared knowledge acquired from there firms to good use.

2) The policy makers have to help firms increase their innovation level in the fields. They need to increase all the activities that we found out and discussed in the

innovation process that needs to be increased. New policy should be able to help firms increase their competitiveness through the cooperation between firms and R&D, UR department. New policies that help firms in their innovation process to finance the innovation activities and get new knowledge to be able to increase their productivity according to the needs of the market.

3) We assume that Catalan SMEs/ LMT have a long track record with the innovation process in the field. The development of this innovation structure will help firms in Catalonia to increase their productivity, especially when policy makers start to increase their support to them. We notice the support to firms from policy maker is imitated through our analysis of the field and the comparison between our Catalan frameworks with other EU countries. Also the policy strategy needs to identify the return of investment on innovation activities in SMEs/ LMT firms when they start to increase their spending on innovation. It is a future comment to the research to investigate this area to encourage policy makers to change their decision and policy in this regard.

References (in alphabetical order)

- D. Ahlstrom: Innovation and growth: How business contributes to society. *Academy of Management Perspectives*, 2010, 24, 11, 24.
- A. Anderson and L.M.B. Cabral: Go for brake or play it safe? Dynamic competition with choice of variance. *The Rand Journal of Economics*, 2007, 38, 593-609.
- L. Argote, B. McEvily, and R. Reagans: Managing knowledge in organizations: an integrative framework and review of emerging themes. *Management Science*, 2003, 49, 571-82.
- A. Arundel, C. Bordoy and M. Kanerva: 'Neglected innovators: How do innovative firms that do not perform R&D innovate? .Results of an analysis of the Inn barometer 2007 Survey No. 215, *INNO-Metrics. Thematic Paper*, 2008, MERIT March 31.
- D. Audretsch and M. Vivarelli: Firm size and R&D spillovers: evidence from Italy, *Small Business Economic*, 1996, 9, 249:258.
- K. De Backer, K.V. Lo'pez-Bassols, and C. Martinez: "Open innovation in a global perspective: what do existing data tell us?", OECD Science, *Technology and Industry working papers*, 2008/4, OECD Publishing, OECD, Paris, 2008.
- M. Badescu & C. Garcés-Ayerbe: "The impact of information technologies on firm productivity: Empirical evidence from Spain", *Technovation*, 2009, 122-129.
- J.A.C. Baum, T. Calabrese, and B.S. Silverman: Don't go it alone: alliance network composition and startup's' performance in Canadian biotechnology, *Strategic Management Journal*, 2000, 21 (3), 267–294.
- G. Bender, S. Laestadius: Non-science based innovativeness: on capabilities relevant to generate profitable novelty. In: Bender, G., Jacobson, D., Robertson, P.L. (Eds.), *Non-Research-Intensive Industries in the Knowledge Economy. Journal for Perspectives on Economic Political and Social Integration*, 2005, 123–170.
- G., D. Bender, Jacobson and P. L. Robertson: Non-Research-Intensive Industries in the Knowledge Economy, Published in *Perspectives on Economic Political and Social Integration, Special Edition XI*, 2005, No 1-2.
- R. Belderbos, M. Carree, B. Lokshin: Co-operative R&D and firm performance. *Research Policy*, 2004, 33, 1477–1492.
- H. Berends, R. Garud, K. Debackere and M. Weggeman: Thinking along: crossing boundaries in knowledge work, *International Journal of Technology Management*, 2011, 69–88.

- B. Bozeman: Technology transfer and public policy: a review of research and theory. *Research Policy*, 2000, 29, 627–655.
- F. Bougrain, H.B. Haudeville: Innovation collaboration and SMEs internal research capacities. *Research Policy*, 2002, 31, 735–747.
- L.M.B. Cabral: R&D Competition when firms choose variance. *Journal of Economics and Management Strategy*, 2003, 12, 139-150.
- V. A. Carlos and B. G. Andres: Impact on firms of the use of knowledge providers: a systematic review of the literature, *Munich Personal RePEc Archive, MPRA Paper*, 2012, 41042, 16:22.
- H. Chesbrough and K. Schwartz: Innovating business models with co-development partnerships. *Research-Technology Management*, 2007, 50, 55-9.
- H. Chesbrough: Open innovation. *Harvard University Press. Cambridge, MA*, 2003.
- H. Chesbrough: Open Innovation: The new imperative for creating and profiting from technology. *Harvard Business School Press, Boston, MA*, 2003.
- H. Chesbrough: Open Business models: How to thrive in a new innovation landscape. *Harvard Business School Press, Boston, MA*, 2006.
- H. Chesbrough and A.K. Crowther: Beyond high tech: early adapters of open innovation in other industries. *R&D Management*, 2006, 36:299-236.
- H. Chesbrough, K. Lim and Y. Ruan: Open innovation and patterns of R&D competition. *Working Paper*, 2007.
- H. Chesbrough: Open innovation: A new paradigm for understanding industrial innovation, in H. Chesbrough, W. Van haverbeke and J. West: Open innovation: Researching a new paradigm. *Oxford University Press*, 2006.
- H. Chesbrough and K.Schwartz: Innovating business models with Co-development partnerships. *Research Technology Management*, 2007, 50, 55-9.
- H. Chesbrough, K. Lim and Y. Ruan: Open innovation and patterns of R&D competition. *Working Paper*, 2007.
- H. Chesbrough, M. Appleyard: Open innovation and strategy. *California Management Review*, 2007, 50, 57-76.
- H. Chesbrough, W. Vanhaverbeke, J. West: Open Innovation: Researching a New Paradigm. *Oxford University Press, London*, 2006

- H. Chesbrough: Why companies should have open business models. *Sloan Management Review*, 2007, 48, 22-28.
- H.W. Chesbrough: The era of open Innovation, *MIT Sloan Management Review*, spring, 2003, 515: 35:41.
- H. Chesbrough and A. Prencipe: Networks of innovation and modularity: a dynamic perspective, *International Journal of Technology Management*, 2008, 42, 4, 414-425.
- D. Chiaroni: The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm, *Technovation*, 2011, 31, 34-43.
- S. Christopherson: Technology transfer models improving the potential for business establishment and job creation, presentation at OECD round table on higher education in regional and city development, 2010, Paris OECD. Also at:
www.oecd.org/document/3910,3343,en_2649_35961291_45073703_1_1_1_1,00.htm
- PH. Cooke: Regional Innovation System, Clusters and the Knowledge Economy, Industrial and Corporate Change. *Oxford University Press*, 2001, 10.
- M. W. Cohen, R. R. Nelson, J. Walsh: Links and impacts: the influence of public research on industrial R&D, *Management Science*, 2002, 48, 1–23.
- W.M Cohen and D.A. Levinthal: Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 1990, 128–152.
- CTecno: The Technology Sector in Catalonia, Pento Co-ordinated and supervised by CTecnos organization and procedures section, *CTecno Publishing*, 2013.
- L. Dahlander and D. M.Gann: How Open is Innovation? *Research Policy*, 2010, 39, 699–709.
- D. M. Decarolis, D.L.: the impact of stocks and flows of organizational knowledge on firm performance: an empirical investigation of the biotechnology industry, *Strategic Management Journal*, 1999, 20, 953-968.
- K. Dittrich and G. Duystres: networking as means to strategy change: the case of open innovation in mobile telephony. *Journal of Product Innovation Management*, 2007, 24, 6, 510-521.
- B. Ebersberger, C. Blosh, S. J. Hestad, E. V. De Velde: Open innovation practices and their effect on innovation performance, *International Journal of innovation and Technology management*, 2010.

- E. Enkel: Attributes required for profiting from open innovation in networks, *International Journal of Technology Management (In Press)*, 2010, 344- 371.
- E. Enkel, O. Gassmann, and H, Chesbrough: "Open R&D and open innovation: exploring the phenomenon", *R&D Management*, 2009, Vol. 39 No. 4, pp. 311-6.
- D. Faems, B. Van Looy, k. Debackere: Inter organizational collaboration and innovation: toward a portfolio approach. *Journal of Product Innovation Management*, 2005, 22, 238–250.
- W. Faulkner: Conceptualizing knowledge used in innovation: a second look at the science-technology distinction and industrial innovation. *Science, Technology & Human Values*, 1994, 425–458.
- C. Freeman: *The Economics of Industrial Innovation, Second ed. Frances Pinter, London, 1982.*
- C. Freeman: The economics of technological change. *Cambridge Journal of Economics*, 1994, 18, 463- 514.
- M. Fritsch and A. Stephan: Regionalization of Innovation Policy- Introduction to the Special Issue. *Research Policy*, 2005, 34, 1123-1127.
- JR, Galbraith, DA. Nathanson DA: *Strategy Implementation: The Role of Structure and Process*, St. Paul, Minnesota: West Publishing Company, 1978.
- A. Garrido and N Duch: *Memoria Economía de Catalunya 2008, Cambra Oficial De Comerc, Industria I Navegación de Barcelona, Barcelona, 2009.*
- MA. Geletkanycz and DC Hambrick: The external ties of top executives: implications for strategic choice and performance. *Admin Sci Q*, 1997, 42:654–81.
- K.W. Glaister and R. J. Falshaw: Strategic planning: still going strong? *Long Range Planning*, 1999, 107–116.
- C. Grimpe, W. Sofka: Search patterns and absorptive capacity: Low- and high-technology sectors in European countries, *Research Policy*, 2009.
- O. Gassmann: Opening up the innovation process: Towards an agenda. *R&D Management*, 2006, 36, 223-6.
- Government of Catalonia: *Annual of Catalan SMEs, Economic and Financial Result*, Source found on line at:
- <http://web.pimec.org/repositori/documents/actualitat/es/AnuariPimeCatalana2012.pdf>

- M. Guerrero, D. Urbano, J Cunningham, D, and Organ: Entrepreneurial universities in two European regions: a case study comparison, 2012, 10.1007/s10961-012-9287-2.
- E. Hall, Robert and I. Charles Jones: Why Do Some Countries Produce So Much More Output Per Worker Than Others? *Quarterly Journal of Economics*, 1999, 83-116.
- B. H. Hall: University- industry partnerships in the United State. In Contzen, J.-P., Gibson, D. and Heitor, M.V. eds, *Rethinking Since Systems*, 2004.
- P. Hansen, G. Serin: Will low technology products disappear?: the hidden innovation processes in low technology industries. *Technological Forecasting and Social Change*, 1997, 55, 179–191.
- J.L. Hervás-Oliver, J. Albors-Garrigós: The Role of the Firm’s Internal and Relational Capabilities InClusters: When Distance And Embeddedness Are Not Enough, *Journal of Economic Geography*, in press, 2009.
- H. Hirsch-Kreinsen, D. Jacobson, S. Laestadius and S. Keith: Low-tech industries and the knowledge economy: state of the art and research challenges, *STEP REPORT*, 2003, SINTEF.
- H. Hirsch-Kreinsen, D. Jacobson, S. Laestadius, and K. Smith: Low and medium technology industries in the knowledge economy: the analytical issues. In: Hirsch-Kreinsen, H., Jacobson, D., Laestadius, S. (Eds.), *Low-tech Innovation in the Knowledge Economy*. Peter Lang, Frankfurt Main, 2005, pp. 11–30.
- C. Huang, A. Arundel and H. Hollanders: ‘How firms innovate: R&D, non-R&D, and technology adaption’, *The UNU-Merit Working papers series*, 2010-027.
- E. K. R. E. HUIZINGH: Open innovation: State of the art and future perspectives. *Technovation*, 2011, 31, 2-9.
- IDESCAT, Source found on line at: www.idescat.cat, Link, <http://www.idescat.cat/economia/inec?tc=3&id=8301&lang=en>.
- IDESCAT, Source found on line at: www.idescat.cat, December, 12, 2012. Next period, 2011: June 2013, Link, <http://www.idescat.cat/economia/inec?tc=3&id=6111&lang=en>
- IDESCAT, Source found on line at: www.idescat.cat, period, March 11, 2013. 1 quarter, 2013, June 10, 2013. Link, <http://www.idescat.cat/economia/inec?tc=3&id=0814&lang=en&dt=201204&x=8&y=9>

- LB, Jeppesen KR, Lakhani: Marginality and problem-solving effectiveness in broadcast search. *Organization Science*, 2010, 21, 1016:1033.
- P. Jones: Are educated workers really more productive? *Journal of Development Economics*, 2001, 64 (1), 57–79.
- A. Kaloudis, T. Sandven, K. Smith: Structural change, growth and innovation: the roles of medium and low-tech industries, 1980–2002. In: Bender, G., Jacobson, D., Robertson, P.L. (Eds.), *Non-Research-Intensive Industries in the Knowledge Economy. Journal for Perspectives on Economic Political and Social Integration*, 2005, 11, 49–73.
- H. Kim & Y. Park: The effects of open innovation activity on performance of SMEs: The case of Korea, *International Journal of Technology Management*, (forthcoming), 2010.
- E. Kirner, S. Kinkel, A. Jaeger: Innovation paths and the innovation performance of low-technology firms-An empirical analysis of German industry. *Research Policy*, 2009, 447-458.
- A. Klevorick, R. Levin. R. Nelson, S. Winter: On the sources of significance of inter-industry differences in technological opportunities, *Research Policy*, 1995, 185-205.
- H. Kreinsen, D. Jacobson, S. Laestadius, (Eds.): *Low-Tech Innovation in the Knowledge Economy. Peter Lang, Frankfurt*, 2005a, 11–30.
- H -Kreinsen, H: Low-tech, innovations. *Industry & Innovation*, 2008, 15, 19–43.
- K. Koschatzky: The role of R&D services in managing regional knowledge generation-a regional differentiation, in: Karlsson, C., Flensburg, P., Hörte, S.A. (Eds.), *Knowledge spillovers and knowledge management*. Cheltenham: Edward Elgar, 2004, 254-297.
- K. Laursen and A. Salter: Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms, *Strategic Management Journal*, 2006. 27: 131-150.
- K. Laursen, A. Salter: Searching high and low: what types of firms use universities as a source of innovation? *Research Policy*, 2004, 33, 1201:1215.
- Ch. Lee, K. Lee, J. Pennings: Internal capabilities, external networks, and performance: a study on technology-based Ventures, *Strategic Management Journal*, 2001, 22, 615- 640.
- U. Lichterthaler: Externally commercializing technology assets: an examination of different process stage. *Journal of Business Venturing*, 2008, 23, 317-30.
- U. Lichtenthaler and H. Ernst: “Opening up the innovation process: the role of technology aggressiveness”, *R&D Management*, 2009, Vol. 39 No. 1, pp. 38-54.

- U. Lichtenthaler: "Outbound open innovation and its effect on firm performance: examining environmental influences", *R&D Management*, 2009, Vol. 39 No. 4, pp. 317-30.
- U. Lichtenthaler and H. Ernst: Developing reputation to overcome the imperfections in the markets of knowledge. *Research Policy*, 2007, 37- 55.
- A.N. Link, D.S. Siegel, B. Bozeman: An empirical analysis of the propensity of academics to engage in informal university technology transfer, *available at SSRN: <http://ssrn.com/abstract=902207>*, 2006.
- B.A. Lundvall: Introduction to national systems of innovation, in: Lundvall, B.A. (Ed.). *National Systems of Innovation*. Pinter, London, 1992, 1–22.
- J.G. March: Exploration and exploitation in organizational learning. *Organization Science*, 1991, 2, 71-87.
- M. V. J., Maula, T. Keil & J.-P Salmenkaita: Open innovation in systemic innovation contexts. In H. Chesbrough, W. Vanhaverbeke & J. West (Eds.), *Open Innovation: Researching a New Paradigm* Oxford & New York: Oxford University Press, 2006, 241-257.
- G.S. McMillan, F. Narin, D.L. Deeds: An analysis of the critical role of public science in innovation: the case of biotechnology. *Research Policy*, 2000, 29, 1–8.
- B. McEvily, A. Zaheer, B. Ties: a source of firm's heterogeneity in competitive capabilities, *Strategic Management Journal*, 1999, 20, 1133-1156.
- P. Mohnen and J. Mairesse: Using innovation surveys for econometric analysis, in Hall, B.H, Rosenberg, N. Eds. *Handbook of The Economic of Innovation*, 2005.
- X. Molina and T. Martinez: How Much Difference is there between Industrial District Firms? A Net Value Creation Approach, *Research Policy*, 2004, No 33, 473-486.
- H. Mintzberg, IJ Lampe, J Quinn, S Ghoshal: *The Strategy Process: Concepts, Contexts and Cases* (4th ed.). Upper Saddle River, New Jersey: Prentice-Hall, 2003.
- R. Narula: R&D collaboration by SMEs: new opportunities and limitations in the face of globalisation, *Technovation*, 2004, 24, 153:161.
- R.R. Nelson: *National Systems of Innovation: A Comparative Study*. Oxford University Press, Oxford, 1993.
- M.J. Nieto, L. Santamaría: The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, 2007, 27, 367–377

- OECD, Organization for Economic, Co-operation and Development Source found on line at: <http://www.oecd.org/edu/imhe/46826969.pdf>.
- OECD, Reviews of regional innovation, Catalonia, Spain, OECD paper, 2010, 1995- 6585 online.
- OECD, Organization for Economic, Co-operation and Development, review of regional Innovation, Assessment and Recommendations, Catalonia, Spain, OECD paper, 2010.
- OECD, Reviews of Regional Innovation, Regions and Innovation Collaborating across Borders, *OECD Paper*, 2013, ISBN 978-92-64-20530-7 (PDF)
- OECD, Higher education in regional and city development. The autonomous region of Catalonia, Spain. Paris: *OECD Publishing*, 2010.
- OECD, Open Innovation in Global Networks. Paris: *OECD Publishing*, 2008.
- OECD, Policy Responses to the Economic Crisis: Investing in Innovation for Long-Term Growth, OECD, Paris, 2009.
- OECD, Science, Technology and industry Outlook, *OECD Paris*, 2006.
- Open- Alps, Survey Data Analysis, *Politecnico di Torino Piedmont – Italy*, Open Alpa, 5-3-1 D.
- E. Olson, O. Walker, and R. Ruekert: Organizing for Effective New Product Development: The Moderating Role of Product Innovativeness. *Journal of Marketing*, 1995, 59(1):48–62.
- K. Pavitt: Sectoral patterns of technical change: Towards a taxonomy and a theory. *Research Policy*, 1984, 13, 343/373.
- V. Parida, C. Johansson, T. C. Larsson: Implementation of Open Innovation practices in Swedish manufacturing industry, *International Conference On Engineering Design*, 2009, ICED'09.
- G. P. PISANO& R.VERGANTI: What Kind of Collaboration Is Right for You? *Harvard Business Review*, 2008, 86, 78-87.
- PIMEC, Anuario de la Pime Catalana. Resultas Economics I Financiers, *PIMEC Paper*, 2007-2011, 2013, B-18670-2013.
- W.W. Powell, J. Owen-Smith, Network position and firm performance: organizational returns to collaboration in the biotechnology industry. *Research in the Sociology of Organizations*, 1999, 16, 129–159.
- M.E. Porter and S. Stern: Innovation: Location matters. *Sloan Management Review*, 2001, 28–43.

- L. Raymond & J. St-Pierre: R&D as a determinant of innovation in manufacturing SMEs: An attempt at empirical clarification. *Technovation*, 2010, 48–56.
- D. Rigby and C. Zook: Open market innovation. *Harvard Business Review*, 2002, 80-89.
- S. Roper, J. Du & J. H. Love: Modelling the innovation value chain. *Research Policy*, 2008, 961-977.
- P.L. Robertson, P.R. Patel: New wine in old bottles: technological diffusion in developed economies. *Research Policy*, 2007, 36, 708–721.
- S. I. Saguy: Academia-industry innovation interaction: Paradigm shifts and avenues for the future. *Procedia Food Science*, 2011, 1875 – 1882.
- P. Sanchez and J. Ricart: Business model innovation and sources of value creation in low income markets. *European Management Review*, 2010, 7:138-154.
- J. Sáenz, N. Aramburu and O. Rivera, 'Knowledge sharing and innovation performance: A comparison between high-tech and low-tech companies', *Journal of Intellectual Capital*, 2009, 10, 22–36.
- L. Santamaria, M.J. Nieto, A. Barge-Gil: Beyond formal R&D: Taking advantage of other sources of innovation in low-and medium-technology industries. *Research Policy*, 2009, 507-517.
- L. Santamaria, M.J. Nieto, A. Barge- Gil: The relevance of different Open Innovation strategies for R&D performance, *Cuadernos de Economía y Dirección de La Empresa*, 2010, 45, 1138-5758.
- W. Schoenmakers, G. Duysters: Learning in strategic technology alliances. *Technology Analysis & Strategic Management*, 2006, 18, 245–264.
- A. Segarra-Blasco: Innovation and productivity in manufacturing and service firms in Catalonia: a regional approach, *Economics of Innovation and New Technology*, 2010, pp.233-258.
- A. Segarra & M. Teruel: Productivity and R&D sources: evidence for Catalan firms, *Economics of Innovation and New Technology*, 2011, 727-748.
- S. A. Shane: Economic Development through Entrepreneurship: Government, *University and Business Linkages*, Cheltenham: Edward Elgar, 2005.
- D. Siegel, D. Waldman, L. Twater and A. LINK: Commercial knowledge transfers from universities to firms: improving the effectiveness of university-industry collaboration. *Journal of High Technology Management Research*, 2003, 14, 111-133.

- D. Siegel: Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: quality evidence from commercialization of university technologies. *Journal of Engineering and Technology Management*, 2004, 21, 115-142.
- D.S. Siegel, D. Waldman and A. Link: Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study, *Research Policy*, 2003, 32, 27 -48.
- G. Slowinski and M.W.Sagal: *The Strongest Link: Creating Profitable and Enduring Corporate Partnerships*. New York, AMACOM Press, 2003.
- S. Smith: Beg, borrow, and deal? Entrepreneurship and financing in new firm innovation. SSRN, Working Paper, Available at: [HTTP://SSRN.COM/abstract=1573685](http://SSRN.COM/abstract=1573685), 2010.
- A. Spithoven: Building absorptive capacity to organize inbound open innovation in traditional industries, *Technovation*, 2010, 30,130-141.
- J. W. Spencer: How relevant is university-based scientific research to private high-technology firms? a United States–Japan comparison. *Academy of Management Journal*, 2001, 44, 432–440.
- C. TERWIESCH and K. T. ULRICH: *Innovation Tournaments: Creating and Selecting Exceptional Opportunities*. Harvard Business School Press, 2009.
- J. Torrent & J. Vilaseca: *La empresa red. Tecnologías de la información y la comunicación, productividad y competitividad*, Ariel, Barcelona, 2008.
- F. D. B. Trujillo-Ruiz, J.L. Hervás- Oliver, Internal and relational knowledge and absorptive capacity in SMEs: Understanding firms innovation performance through R&D and Non R&D activities, *DRUID Paper*, 2001, M00, L20, C10.
- Su, Y.S., Tsang, E.W.K., & M. W. Peng: How do Internal Capabilities and External Partnerships Affect Innovativeness? *Asia Pacific Journal of Management*, 2009, 26, 309:331.
- K.H. Tsai and J.C. Wang: External technology acquisition and firm performance: a longitudinal study. *Journal of Business Venturing*, 2008, 91–112.
- K.H. Tsai and J.C. Wang: External technology sourcing and innovation performance in LMT sectors: An analysis based on the Taiwanese Technological Innovation Survey. *Research Policy*, 2009, 38, 518-526.

- N. Tunzelmann von and V. Acha: 'Innovation in "Low-Tech" Industries', in J. Fagerberg, D. Mowery and R.R. Nelson (eds), *The Oxford Handbook of Innovation*. Oxford University Press: Oxford, 2005, pp. 407–432.
- M. Tushman: Technical communication in R&D laboratories: The impact of project work characteristics. *Academy of Management Journal*, 1977, 20, 624–645.
- J. Valls, N. Mancebo et al: Innovacions organitzatives i competitivitat industrial. In: *Papers d'Economia Industrial*, 20. Departament d'Indústria, Generalitat de Catalunya, Barcelona, 2004.
- J. Valls Pasola: Business relations and external players in the innovation process. *Paradigmes*, 2008.
- W. Vanhaverbeke, V. Van de Vrande and H. Chesbrough: Understanding the advantages of open innovation practices in corporate venturing in terms of real options. *Creativity and Innovation Management*, 2008, 17,4.
- Van Helleputte and Reid: Tackling the paradox: can attaining global research excellence can be compatible with local technology development? *R&D Management*, 2004, 34, 33-44.
- V. De Varande, J. P. J. D. Jong, and W. Vanhaverbeke & M. D. Rochemont: Open innovation in SMEs: Trends, motives and management challenges, *Technovation*, 2009, 29, 423 – 437.
- R. Veugelers, B. Cassiman: R&D cooperation between firms and universities. Some empirical evidence from Belgian manufacturing, *International Journal of industrial Organization*, 2005, 23, 355-379.
- V. de Vrande, J. P. J. de Jong., W. Vanhaverbeke, & M. de Rochemont, M: Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 2009, 423-437.
- E. Von Hippel: The sources of innovation. *New York: Oxford University Press*, 1988.
- O. Vuola, A.P. Hameri: Mutually benefiting joint innovation process between industry and big-science. *Technovation*, 2006, 26, 3–12.
- J. West and M. Bogers: Contrasting innovation creation and commercialization within open, user and cumulative innovation, *working paper, San Jose´ State University, San Jose,CA*, 2010.
- R. Wieser: Research and development, productivity, and spillovers: Empirical evidence at the firm level. *Journal of Economic Surveys*, 2005, 19, 587-621.

D.C. Wyld: Speaking up for customers: Can sales professionals spark product innovation?
Academy of Management Perspectives, 2010, 24, 80-82.

D.C. Wyld: and R. Maurin: keys to innovation: the right measures and the right culture?
Academy of Management Perspective, 2010, 24, 62-77.

R. Yin: Case study research, design and methods. *Beverly Hills, CA: Sage, 1984.*

S.A. Zahra, H.J. Sapienza and P. Davidsson: Entrepreneurship and dynamic capabilities: a review, model and research agenda. *Journal of Management Studies*, 2006, 43, 917–55.

Annex 1

Contribution of Intermediate

In the framework of this PhD work, the following article was published:

El Rayyes, A.; Valls-Pasola. J.: (2013) The Effect of Research & Development Activities and Open Innovation Activities: A Key to Low/ Medium Technology Industries and Firms in Catalonia. *International Journal of Innovation Science* Vol. 5, Num. 4 .

This Journal is indexed in the following databases: Scopus, EBSCOhost, (EJS), National Science and Technology Library, Metapress, Proquest and Compendex. The Journal is also in review for acceptance into Thomson Reuters / JCR / Web of Knowledge.

Other activities

I have attended during my PHD Process different seminar and workshops; I would like to mention the following:

1st Seminar: For doctorate students in Science and Innovation of Private Sector Companies, Barcelona, 12 of November, 2012.

2nd Seminar: For doctorate students in Science and Innovation of Private Sector Companies, Barcelona, 12 of November, 2013.

1st Workshop: For doctorate student in Business Research, Barcelona, 15 of November, 2011.

2nd Workshop: For doctorate student in Business Research, Barcelona, 15 of November, 2012.

3rd Workshop: For doctorate student in Business Research, Barcelona, 15 of November, 2013.

1st Doctoral workshop: The Department of Strategy and General Management, Barcelona, 15 December, 2013 to 17 December 2013.