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# OPEN INNOVATION IN GLOBAL NETWORKS

**Candidate:** Norman Lubello

**Registration number:** 712453

**Tutor:** Silvio M. Brondoni

**Coordinator:** Silvio M. Brondoni

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## Table of Contents

Declaration of originality and copyright statement	I
Table of Contents	II
List of Tables	IV
List of Figures	VI
Acronyms and Abbreviations	VIII
Bibliography	140
<b>Chapter 1. Introduction</b>	<b>1</b>
1.1 Problem Statement	1
1.2 Methodology	3
1.3 Research questions	7
<b>Chapter 2. From Technology-driven to Market-driven Innovation</b>	<b>8</b>
2.1 Convergence and Divergence	11
2.2 From Closed to Open Innovation	20
2.2.1 The vertical integration model	20
2.2.2 The Proprietary Platforms Failure on Electronics Markets	23
2.3 Open Innovation Processes	25
2.3.1 Innovation and Market-driven Management	27
2.3.2 Sourcing Processes	31
2.3.3 The Complementary Effect	33
2.3.4 Technology Licensing	37
2.3.5 Revealing and Open-Source Software	43
<b>Chapter 3. Knowledge Sourcing and Real Options</b>	<b>51</b>
3.1 Knowledge Sourcing: A Theoretical Overview	51
3.2 External Source as Real Options	55
3.3 Knowledge Sourcing Facilitators	63

<b>Chapter 4. External Sources for Innovation</b>	<b>66</b>
4.1 Public Policies and University-Industry Relationships	67
4.2 Customer empowerment and User innovation	77
4.3 Start-Up and SMEs as Complementary Sources of Innovation	87
4.4 Co-opetition and Inter-firm R&D	92
<b>Chapter 5. Open Innovation and Networks</b>	<b>98</b>
5.1 Barriers to Innovation	98
5.2 Not Invited Here Syndrome	103
5.3 Innovation Intermediaries	108
5.4 Competition among Innovative Networks	112
<b>Chapter 6. Open Innovation in Samsung Electronics</b>	<b>116</b>
6.1 A Company Overview	116
6.2 Internal R&D and Knowledge Management	119
6.3 Openness in Samsung's Networking	123
6.3.1 Samsung's propensity to openness	123
6.3.2 Samsung's Sources of Innovation	125
6.3.2.1 <i>Universities and Research Centers</i>	125
6.3.2.2 <i>Customer Empowerment and Open Source</i>	127
6.3.2.3 <i>Competitors as Sources of Innovation</i>	129
6.3.2.4 <i>Start-Up and SMEs</i>	132
<b>Chapter 7. Conclusions</b>	<b>135</b>
7.1 Findings and Final Remarks	135
7.2 Limitations and Emerging Issues	137
7.3 Managerial implications	139

## List of Tables

**Table 1:** Geographical distribution for publications about OI

**Table 2:** List of top OI journals

**Table 3:** Electronics firms' impact in 2015

**Table 4:** Comparison of divergent markets in 2014

**Table 5:** Closed innovation main features

**Table 6:** Main standards in 20<sup>th</sup> century in electronics computing

**Table 7:** Market-driven quotes tied to innovation management

**Table 8:** Main sources in innovation networks

**Table 9:** Comparison between complementary and substitution effects

**Table 10:** Examples of innovation - imitation dynamics in electronics

**Table 11:** Comparison between innovation models

**Table 12:** Open source projects by firms

**Table 13:** SourceForge platform for open source

**Table 14:** Differences between knowledge sourcing

**Table 15:** Technological knowledge sourcing and time horizons

**Table 16:** Sales of electronics devices on US market in 2015

**Table 17:** Competition on largest mobile handset manufacturers

**Table 18:** Comparison between closed and open approaches to innovation

**Table 19:** Comparison for Real option theory

**Table 20:** Gross Domestic Spending on R&D by country

**Table 21:** Trend about patents by country

**Table 22:** Trend of US patents in the second half of twentieth century

**Table 23:** University – industry links

**Table 24:** Example of cultural divide

**Table 25:** Examples of user innovation

**Table 26:** Innocentive: data and facts

**Table 27:** User engagement in electronics by Lego

**Table 28:** Worldwide smartphone sales to end-users in 2013

**Table 29:** Open Handset Alliance membership by industry

**Table 30:** Chief officers tasks in OI implementation

**Table 31:** Attitudes to knowledge management

**Table 32:** Main studies for NIH

**Table 33:** Ninesigma: vision and mission

**Table 34:** Samsung performance in global markets

**Table 35:** Samsung: board of director

**Table 36:** List of main Samsung R&D centers

**Table 37:** Samsung university-industry main goal

**Table 38:** Co-opetitive networks in TV industry

## List of Figures

- Figure 1:** Time distribution for the OI publications
- Figure 2:** Document types for the OI topic
- Figure 3:** Market-driven convergence
- Figure 4:** Technology-driven convergence
- Figure 5:** When convergence become a strategic choice?
- Figure 6:** Technology convergence for electronics devices
- Figure 7:** Comparison between costs and benefits from convergence
- Figure 8:** Convergence - divergence dynamics
- Figure 9:** Divergence from smartphone to tablet
- Figure 10:** Convergence - divergence dynamics in IT security software market
- Figure 11:** The vertical integration model
- Figure 12:** R&D output in vertical integration model
- Figure 13:** IBM's example of Net Present Value
- Figure 14:** Framework for an open business model
- Figure 15:** Open innovation processes
- Figure 16:** Outside-in process
- Figure 17:** Relationship between innovation source and performance
- Figure 18:** Private investments process
- Figure 19:** Collective invention process
- Figure 20:** Firm's strategic choices in inside-out processes
- Figure 21:** Matrix of inside-out processes based on IPR
- Figure 22:** Firm growth opportunities in IT markets
- Figure 23:** Real option theory and gradual investments
- Figure 24:** Cooper's Stage-Gate model
- Figure 25:** Stage-Gate and sourcing strategies
- Figure 26:** Evolution of Gross Domestic Spending on R&D by country
- Figure 27:** Columbia University licensing agreements
- Figure 28:** R&D expenditure in South Korea
- Figure 29:** Framework for innovation by communities
- Figure 30:** Set of metrics for community evaluation

- Figure 31:** Path of innovation for communities
- Figure 32:** Publication trend for SMEs and OI literature
- Figure 33:** SMEs keep or sell dilemma
- Figure 34:** Complementarities among SMEs and large firms
- Figure 35:** Geographical distribution of the academic research about SMEs and OI
- Figure 36:** Publication trend for co-opetition and innovation
- Figure 37:** Game theory approach to co-opetition
- Figure 38:** Gap between locus and innovation
- Figure 39:** Intermediary roles in the innovation process
- Figure 40:** Innovative network from a focal firm perspective
- Figure 41:** Set of relationships for an innovation-based network
- Figure 42:** Samsung: business overview
- Figure 43:** Samsung internal R&D organisation
- Figure 44:** SAIT geographical distribution
- Figure 45:** Samsung expenditures on absorptive capacity
- Figure 46:** Global Research Outreach: research themes
- Figure 47:** Market share trend in TV industry
- Figure 48:** New product development in Samsung Accelerator



## **Acronyms and Abbreviation**

CEO	Chief Executive Officer
CCO	Chief Customer Officer
ICT	Information and Communication Technologies
IP	Intellectual Property
IPR	Intellectual Property Rights
L&D	Learning and Development
NIH	Not Invented Here Syndrome
NSH	Not Sold Here Syndrome
OI	Open Innovation
OHA	Open Handset Alliance
OSS	Open Source Software
R&D	Research and Development
ROT	Real Option Theory
U-I	University and Industry
VIM	Vertical Integrated Model

# *Chapter 1*

## **Introduction**

### **1.1 Problem Statement**

In the last decades many factors have pushed companies to increase their interest in the openness of their innovation process as a way to win the competition race (Christensen et al., 2005). Time lag, uncertainty, sunk costs and knowledge management are key words in a modern economic scenario where the number of technologies per product increases (Howells et al., 2003) and convergence encloses more and more solutions in a unique hybrid device. Augment in the R&D costs and their inter-disciplinary disposition (Hacklin et al., 2004) involve more partnerships and knowledge sources because firms cannot compete alone in the market (Howells et al., 2003). As a result many firms adopted a network strategy in which each partner actively contributes to the innovation process with different forms of knowledge. This thesis is based on the merge of two strong research streams such as innovation management and network literature. Innovation is seen under the Open Innovation paradigm (Chesbrough, 2003) where external and internal sources and ideas are considered as equal from firms, and the final new product or service is the result of a network shared process.

Chapter two is focused about the context analysis that highlights the transformation from a closed managerial approach, in which innovation was seen as an internal R&D outcome in a technology-driven perspective, to an open one, which the goal is to produce a new product more suitable with the market needs. First it is introduced one of the stronger force in modern technologic environment: the convergence. Firms as Samsung, LGE, Google and Cisco System are aware who a new product may be a synthesis of several technologies blended in a new solution and, this involves a high degree of flexibility about the firm's technological base. At the same time companies cannot invest in so many internal research projects to guarantee

responsiveness in all possible technological evolution, and hence have to find external partners able to replace this internal weakness. Strong network relationships under the Open Innovation umbrella seem to be the managerial answer to modern innovation issues. Firms use external sources integrated with internal ideas because a boundaries transformation in a semi-permeable membrane that maximize the performance by knowledge management since the early stages of innovation process (Gassmann et al., 2010). In fact, chapter one continues with a synthesis of the paradigm with a particular attention about four main kind of processes that allow the network strategy as: sourcing, acquiring, selling and revealing (Dahlander & Gann, 2010). Research is focused on electronics markets because they are particularly affected by convergence, widely deepened from literature (West & Gallagher, 2006; Christensen et al., 2005; West, 2003; West & Dedrick, 2001), and because electronics showed a genuine network orientation.

Chapter three and four moved the discussion on which contributes to innovation process are brought by external sources of innovation. Chapter three is introduced by the Real Option Theory as theoretical framework that supports openness in innovation under costs and risks perspectives. According with Real Option firms invest in several technological opportunities (options) with the aim to diversify their knowledge base and prevent the obsolescence of slow and expensive internal R&D projects (Vanhaverbeke et al., 2008; Vanhaverbeke & Cloudt, 2014). In the chapter four are summarized the main sources of innovation such as: universities and research centers, customers and users, start-up and small and medium enterprises and other larger partners as competitors. Each source displays different contribution to the focal-firm innovation and is studied by different research streams such as: user innovation (Brondoni, 2015; von Hippel, 2007; Jeppesen & Lakhani, 2010), co-opetition (Brandenburger & Nalebuff, 2010) and U-I relationships (Cohen et al., 2002; Mansfield, 1991, Pavitt, 1991; Salter & Martin, 2001). Focus is on the qualitative features of these relationships because previous studies revealed that the number of them is curvilinear related with performance (Laursen & Salter, 2004). Chapter five is focused on network impediments to innovation processes like the Not Invented Here Syndrome (Chesbrough & Crowther, 2006; Lucas & Goh, 2009) and offer an interpretation of network as an instrument to engage the external sources.

Moreover it is introduced a new player that isn't a source of innovation but is useful to increase the efficiency and functioning of the relationships: the intermediary or innomediary. This organisation plays a cohesive role in the network's Connect and Develop economy (Huston & Sakkab, 2006). Chapter six focuses on an example of corporate network, Samsung Electronics, that embrace the previous theoretical issues about Open Innovation, and show a strong example of openness implementation in electronics market.

## 1.2 Methodology

Thesis is based essentially on a literature review. A qualitative approach was preferred because the research questions disposition permitted a strong in-depth analysis through the comparison of different previous research streams. According with the von Hippel's (1988) there are four main sources of innovation, such as:

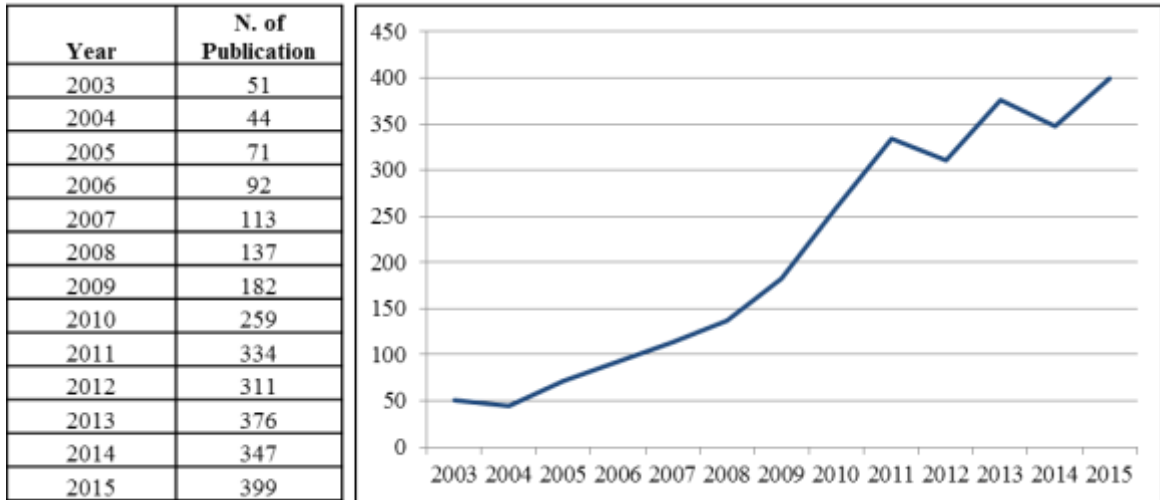
- universities and research centers;
- users;
- start-up and SMEs;
- other firms and competitors.

These players are usually correlated research streams that are considered in agreement to open innovation literature started with the Chesbrough's publications in 2003. From the paradigm adoption to 2015 there was a widely diffusion of the topic witnessed with a growth rate of almost 700% in term of number of documents. Starting from Scopus database, it was entered '*open innovation*' as a keyword, searched in '*title*', '*abstract*' and '*keywords*'. The first filter presented a score of 10.405 publications in the time horizon 2003 - 2016. Later was excluded those publications not in English language for a result of 9.881 items. Finally are considered only those publications matched under two specific scientific areas such as:

- business, management and accounting;
- economics, econometrics and finance.

This filter showed a database of 2.713 publications. Figure 1 shows their quantitative deflagration after the 2005.

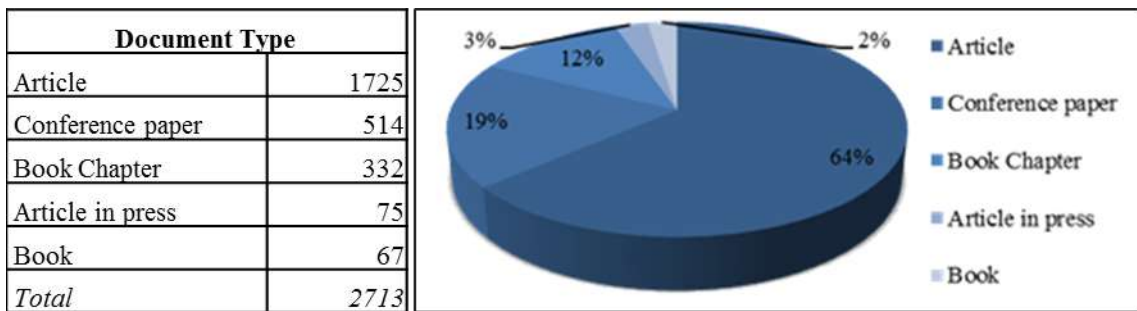
**Figure 1:** Time distribution for the OI publications



Source: based on Scopus Database (2016).

Aforementioned publications are prevailing represented by journal articles (64%) that are the main source of literature analyzed. Figure 2 shows the composition of the publication database based on the document type discrimination.

**Figure 2:** Document types for OI topic



Source: based on Scopus Database (2016).

Moreover not all countries faced the topic with the same intensity. In fact United States are the most important provider for Open Innovation articles. It is tied to the geographical origin of the paradigm forged by Henry Chesbrough, professor at the Haas School of Business, placed at the University of Berkeley, California.

Nevertheless many Asian scholars studied innovation under an open perspective but avoided the specific American term. Beyond the western economies several Asian countries such as China, Taiwan, Japan, South Korea, Singapore and Hong Kong scored high degree of interest in the topic. Table 1 specifically displays the top publishing countries who have hosted more than 10 publication in this specific time horizon.

**Table 1:** Geographical distribution for publications about OI

Top publishing countries (> of 10 publications)					
United States	500	Australia	71	Greece	21
United Kingdom	319	Taiwan	70	South Africa	20
Germany	281	Portugal	56	Hong Kong	18
Italy	209	Belgium	54	Israel	18
China	180	Japan	48	Ireland	17
Netherlands	154	South Korea	46	Malaysia	16
Spain	139	Austria	43	Russian Federation	15
Finland	121	Norway	39	Luxembourg	13
Sweden	98	Brazil	36	New Zealand	13
France	92	India	31	Poland	12
Switzerland	85	Singapore	26	Slovenia	10
Denmark	80	Romania	22	UAE	10
Canada	79	Turkey	21	Estonia	10

*Source:* based on Scopus Database (2016).

Studying the literature it became clear that some journals are particularly oriented to Open Innovation. Trend may be caused by the journals culture and goals that support a specialization in such research streams. Top performers are obviously journals focused on research, technology, innovation and strategy.

Thesis is not based on all the 2.713 publications but focused mainly on those journal articles coherent with the research questions and it was filtered by qualitative criteria, once read the abstracts. Output obtained in the aforementioned way is not the definitive literature, that on the contrary was enriched by other sources identified for their contents suitability.

**Table 2:** List of top OI journals

<b>Top Journals (&gt; of 10 Articles)</b>	
Research Policy	75
International Journal of Innovation Management	66
Research Technology Management	60
International Journal of Technology Management	53
R&D Management	48
Technovation	46
Journal of Product Innovation Management	42
Technological Forecasting and Social Change	40
Journal of Technology Management and Innovation	33
Technology Analysis and Strategic Management	28
European Journal of Innovation Management	27
Lecture Notes in Business Information Processing	26
International Journal of Entrepreneurship and Innovation Management	25
International Journal of Technology Intelligence and Planning	23
California Management Review	22
Strategic Direction	20
Innovation Management Policy and Practice	20
Creativity and Innovation Management	19
Journal of the Knowledge Economy	18
International Journal of Business Innovation and Research	17
International Journal of Innovation and Technology Management	17
International Journal of Innovation and Learning	15
Management Decision	15
Organization Science	15
Portland International Conference on Management of Engineering and Technology	14
European Management Journal	12
Journal of Cleaner Production	12
Management Science	12
IEEE Transactions on Engineering Management	12
Industrial Marketing Management	11

*Source:* based on Scopus Database (2016).

The entirety studied literature offered an integration of Open Innovation with four research streams strictly linked to it, that are:

- Real Option Theory and Stage-Gate model;
- Absorptive Capacity;
- Not Invented Here Syndrome
- Market-driven Management.

Each one of these research streams, or frameworks, is cited in the thesis exclusively for its relationship with innovation management as aid to the literature review.

Last chapter summarizes the literature theoretical outcomes and compared them with an applied business example with the case of Samsung Electronics Ltd. The choice of a Korean *chaebol* was done after a suggestion by the thesis supervisor who recommended a large network, leader in electronics markets and approached to innovation with an Asian perspective, avoiding the classical example of US corporations. According to the methodology used by Chiaroni et al. (2011) or by Huston and Sakkab (2006) the analysis of corporate initiatives in the Open Innovation implementation may be suitable to explain if and how a company has an open orientation in its business model. In the final chapter a case study approach was implemented (Yin, 2013).

The analysis was based on secondary data contained in corporate website and official reports. Chapter six offers two degree of analysis:

- the implementation of Open Innovation at a corporate level;
- the relationships with external sources of innovation included in the corporate network.

### **1.3 Research questions**

Starting from the premises stated in the previous sections, the thesis investigates about these two main research questions:

How does Open Innovation emerge in modern electronics markets?

How do korean *chaebols* implement Open Innovation?



## *Chapter 2*

# **From Technology-driven to Market-driven Innovation**

Innovation has been a flourishing research stream since the studies published by Schumpeter, Arrow and Teece in the past century. Literature diverged for perspectives, points of view and findings, according to geographical contexts, industries and type of firm under examination. After the introduction of Open Innovation paradigm (Chesbrough, 2003), an increasing number of scholars scrutinised how the innovation may be seen with a pluralist focus. In fact, in modern and global competition those firms with the aim to survive in high technology industries have to recognize the advantages descending from the network organization. The boost of obsolescence, convergence and R&D costs led to increase the need for partnerships with other organisations who may be complementary to the specific issues faced by a firm. The closed view of innovation considered a technology-driven approach where a firm invested a large amount of human and financial resources in few technology projects. These projects usually required a time lag of years before the commercialization and, they sometimes became obsolescent at the customers' needs. Closed view followed a push logic in which the only firm's R&D division had the task to innovate strictly inside the organisational boundaries (Billington & Davidson, 2013). Instead Open innovation requires the transformation of the boundaries into a porous membrane opened to a strong integration with external contribution to innovation process. Moreover with a better openness, firms may be more conscious about the market needs in term of product and technology demand. As a result innovation management is transformed from a technology-driven process, in which firms are focused in produce the best technology, to a market-driven process, in which firms invest in a network able to provide the product, or technology, that better match with the market needs. This chapter aims to

study which reasons caused the change of managerial approach in innovation and how the literature analyzes the Open Innovation functioning under a network approach.

Modern society is characterised from a forceful presence of electronics-based technologies. An increasing number of activities in daily life, especially in the western economies, is realized with the aid of electronic devices of different disposition, and this trend is in a clearly growing phase.

Only because of the presence of devices connected to the internet in the OECD countries, it is estimated an increase from 1.7 billion in use today, up to 14 billion devices in 2022 (OECD, 2014).

In fact, if in 2005 already 60% of people between 16 and 74 used the Internet, in 2013 the number of users with the same characteristics is increased to 80%.

Another element to consider is the strong presence of electronics enterprises in the most valuable global brands, where several positions of the top 8 ranking are occupied by firms acknowledged for their range of products of this disposition (Table 3). There are three features that characterise electronics markets as: technology obsolescence, innovation and imitation dynamics and convergence or divergence.

Obsolescence is tied to an environment affected from continuous technological changes that massively influence the firms behavior. In fact, in the past televisions, personal computers, phones and stereos are classic examples of everyday devices powered via a wired system, essentially with a fixed nature. Otherwise modern consumer electronics is increasingly linked to solutions free from the constraints of rigidity. Smartphones, tablets and e-readers may fill the void who older devices were unable to bridge, becoming available to the consumer in every moments. The development of mobile technology is evidenced by an increase in subscriptions of broadband wireless of 250 million in 2008 to 850 million in 2013, social media such as Facebook also showed an increase in access from mobile devices by 28% in 2008 to 75% in 2013 (OECD, 2014). Technological change is clear and businesses have to sustain a rate of product obsolescence very high.

A trend so sharply, albeit with varying degrees of heterogeneity among countries, necessarily involves a change in a global economic structure in which firms tackle with a wide and systemic transformation.

**Table 3:** Electronics firms' impact in 2015

Most valuable brands					
<i>Time</i>	Firm	<i>Forbes</i>	Firm	<i>Financial Times</i>	Firm
1	Apple	1	Apple	1	Apple
2	Google	2	Microsoft	2	Google
3	Microsoft	3	Google	3	Microsoft
4	IBM	4	Coca Cola	4	IBM
5	Visa	5	IBM	5	Visa
6	AT&T	6	Mc Donald's	6	AT&T
7	Verizon	7	Samsung	7	Verizon
8	Coca Cola	8	Toyota	8	Coca Cola

Another feature of the modern competition is the fast dynamic of innovation and imitation in global markets (Brondoni, 2013). Profiting by the commercialisation of firm's new products and services is more complex than in a static and not imitative competition. In this feature there is a clear contrast with the first mover advantages literature, because firms seems to be suffering fast technological contests (Pisano, 2006; Golder & Tellis, 1993). Despite innovators are able to produce valuable new products and services, imitators are likewise able to reach the market with a better solution for the customers (Winter, 2006).

Finally, convergence is a fundamental building block of new hybrid industries, bringing the firms to consider a large array of technologies rather than few alternatives tied to a rigid technology roadmap. Managerial implications by convergence are so determinant that they will be deepened in the following section.

## 2.1 Convergence and Divergence

An important trend that modifies the customer's behavior and widely affects many global markets is convergence. After the Renaissance, scientific knowledge was developed within their respective domains (Roco & Bainbridge, 2002). As socio-economic and managerial problems began more complex, knowledge based on a single discipline was found to be insufficient to resolve them. Since 1980s, a certain number of corporate strategic plans has involved considerations of convergence (Lind, 2004). In addition, rapid globalisation and intensified technological development, involved an augment for the number of technologies per product (Howells et al., 2003). However, convergence has been a much discussed topic with noteworthy economic consequence, but a unique definition was missed because its multifaceted application to science and technology (Nordmann, 2004). A precondition to innovation and convergence is that a new technology does not evolve in isolation but descends by a knowledge recombination among different areas (De Filippi & Arthur, 2009). A concept earlier emerged was the 'technology fusion' suggested by Kodama (1986) in relation to new technologies such as mechatronics and optoelectronics. Technology fusion is tied to the Japanese corporate culture able to innovate after a combination of existing technologies into a hybrid one, with a context of creative imitation (Brondoni, 2013). This perspective is a clearly opposition to the 'breakthrough approach', where firms invest in R&D projects with the goal to totally replace the older generation of technologies (Kodama, 2014). From a technology fusion perspective, innovation process is based on nonlinear, complementary and cooperative approach in which firms use knowledge from several and different fields of science. According with Open innovation (Chesbrough, 2003; von Hippel, 1986; Lakhani & Panetta, 2007) other economic players are involved in firm's R&D project, from the external technology exploration until external technology exploitation (Kodama, 2014; Hung & Chou, 2013).

Technology convergence, that find in the Japanese concept of 'fusion' a great pioneer, has several degree of definition, according to different approaches of the same term. Gauch and Blind (2015) suggested four streams of interpretation:

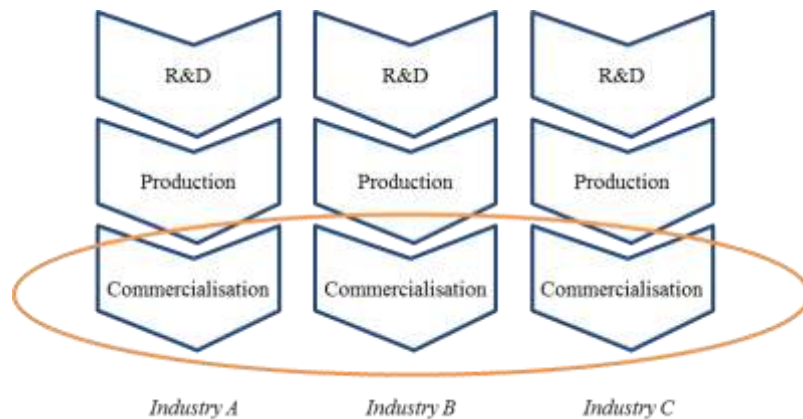
- the creation of a whole new class of products: in this sense convergence is a enrichment over a previous technical solutions with a product based on different technical backgrounds (Adner & Levinthal, 2002).
- the blurring of industries into a hybrid one: it represents the erosion of boundaries among industries because they employ similar machinery and processes at a production level. This stream is strictly tied with Resource based view that looks at industries as group of organisations with similar resources and competences (Barney, 1991; Wernerfelt, 1984).
- the production of General Purpose Technologies (David & Wright, 1999) useful for different actors in the market: the basic assumption is that converging technologies involve the market convergence, with technologies able to capture different needs in several situations.
- the scope of the convergence at a political level: public national, and supra-national institutions, e.g. European Union, aimed to understand, and sometimes to regulate, the evolution of technology convergence in topic such as interoperability, integration of devices, synergies with the social and life sciences spheres (Thorleuchter et al., 2010).

The first two stream may be deepened under different labels as: Market-driven and Technology-driven convergence.

Market-driven convergence (Figure 3) started when different demand structures, from different industries, tend to be in agreement. Customers begin to treat different products in the same way (Broring, 2010). An example is the customer consideration of the entertainment. Early, televisions and personal computers were considered different devices aimed to specific purposes. Later, the introduction of DVD player into the PCs brought customers to consider them as entertainment instruments. Today, customers try to satisfy different needs in a unique transaction and, convergence seems to be a great solution at this issue (Pennings & Puranam, 2001).

Thus, innovation become the way to satisfy the market needs, because firms have to respond to the evolution of the demand side. According to Market-driven management, firms have to accomplish the market needs thanks to outside-in capabilities, showing market sense and a pro-active behavior (Day, 2001).

**Figure 3: Market-driven convergence**

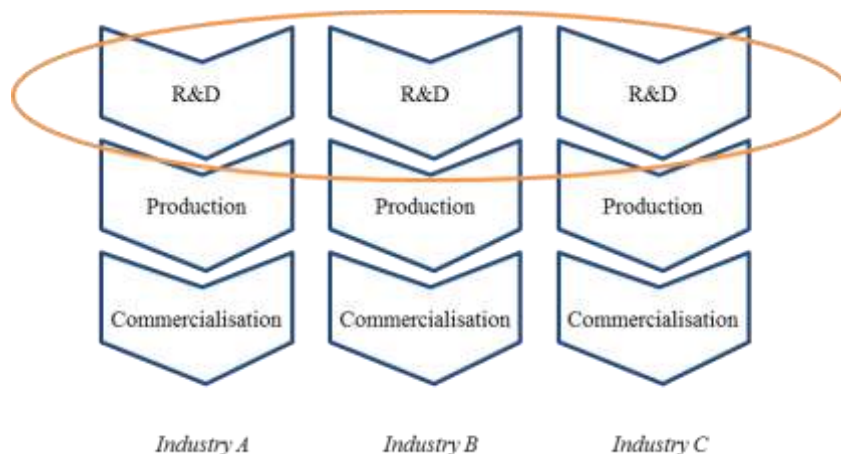


*Source:* based on Developing innovation strategies for convergence (Broring, 2010).

In ‘hyper-competition’ businesses obtain high profits only shaping innovation and employ demand bubbles (Lambin & Brondoni, 2001). Thus, Market-driven convergence is produced by a pull policy (Corniani, 2008).

Instead, Technology-driven convergence occurs at a previous level, when firms plan the innovation strategy. In this case, two or more technologies, or products, offer an integrative opportunity, linking formerly features and peculiarities into a new single output (Lei, 2000).

**Figure 4: Technology-driven convergence**

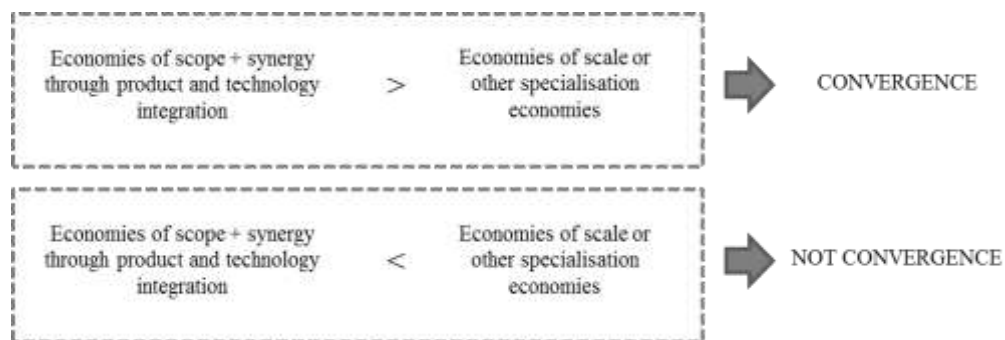


*Source:* based on Developing innovation strategies for convergence (Broring, 2010).

At R&D level there is a recombination of technological knowledge that become significant for innovation strategy. Firms put their innovation output on the market, and customers have a more passive engagement in the process, as a result of a push policy (Corniani, 2008).

At a strategic level, the figure 5 shows that, the choice to make a convergence may be started when prospects for economies of scope and synergy through technologies integration are perceived as higher than prospects for economies of scale within the individual product market (Christensen, 2014).

**Figure 5:** When convergence become a strategic choice?

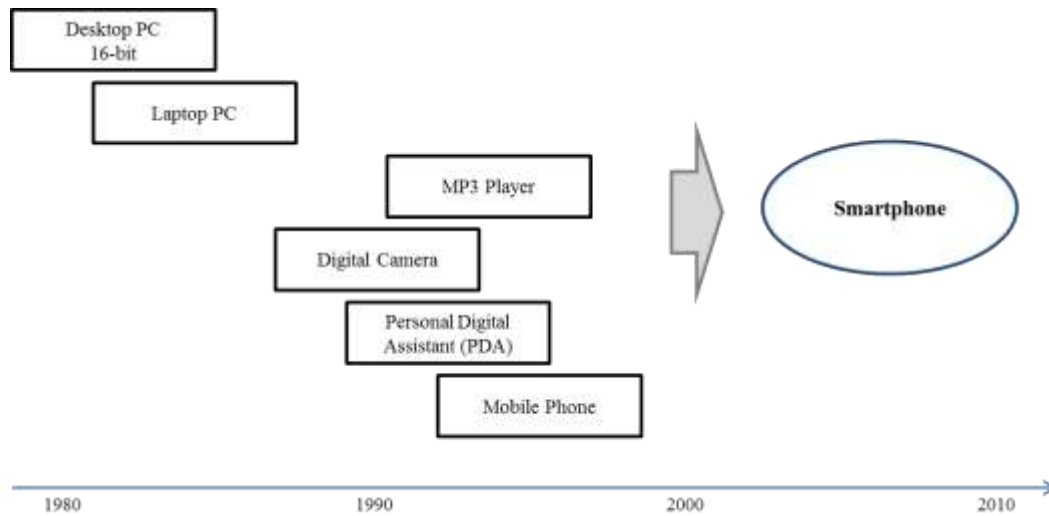


Finally, convergence describes the concept of distinguished items moving toward unity or uniformity or the merging of distinct technologies, devices, or industries into a unified whole (Curran & Leker, 2011). The following figure 6 shows an example of the convergence in electronics.

In order to exploit the full range of implications that these technological changes may have for performance, firms have to possess a wider range of technological competencies (Patel & Pavitt, 1994).

Importantly, convergence has created problems about technological access and market access, and firms may seek to overcome the lack in their internal competencies by entering into alliances of various kinds with other organizations having a complementary range of competencies (Athreye & Keeble, 2000). In other cases firms have capabilities suitable for face technological aspects but neglects complementary assets for bringing products on market (Teece, 1986) and it is compelled to address with other, often larger, partners.

**Figure 6:** Technology convergence for electronics devices



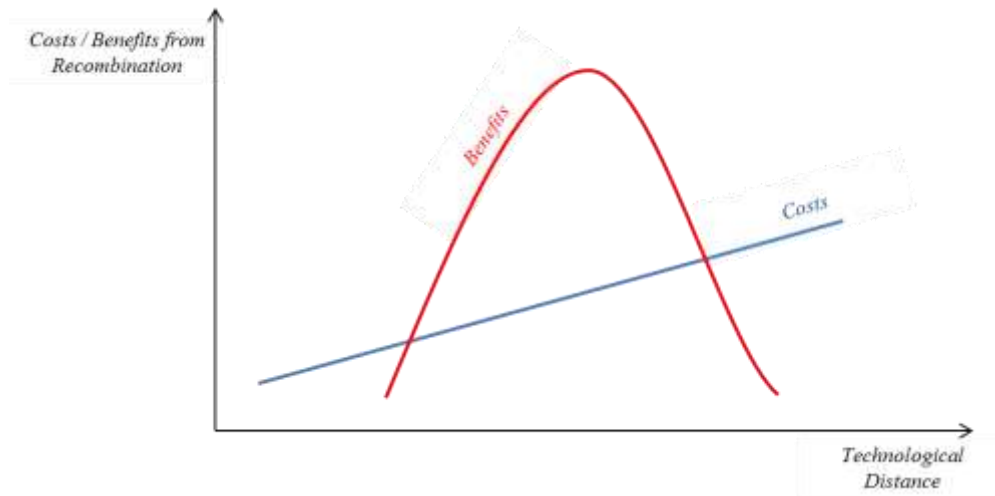
Recombination resulting from convergence produces both benefits and costs. The main benefit is represented by the discovery of novel and innovative products, or solutions, that allow to reach the customer's need (Jeong & Lee, 2015). Costs are related to the overcoming of any cognitive differences (Llerena & Meyer-Krahmer, 2003) such as the use of distinct codes and languages of communication, or the coexistence of different discipline-specific methods.

The comparison between costs and benefits showed that benefits are following an inverted U-shape when the technological distance increases, whereas the costs augment at an increasing rate with the distance (Figure 7). Llerena and Meyer-Krahmer (2003) suggested a relationship between costs, benefits and distance, showing that larger technological gaps produce both fruitful possibilities, and more complex problems.

According with Jeong and Lee (2015), the relationship between costs and benefits pushed the firms to avoid the convergence among macro-level discipline boundaries. Moreover, firms operating in convergent contexts, have to face new competitors who are producing substitute products for the same market (Broring, 2010) Moreover both Market-driven and Technology-driven convergence may lead to a complementation or a substitution of the older industries (Greenstein & Khanna, 1997).



**Figure 7:** Comparison between costs and benefits from convergence



*Source:* Based on What drives technology convergence? Exploring the influence of technological and resource allocation contexts (Jeong & Lee, 2015).

Convergence is not the end of the technological cycle. In fact, firms sometimes need for specialise their products from a convergent phase to a dedicated technology that permits to reduce competition (Christensen, 2014).

**Figure 8:** Convergence - divergence dynamics

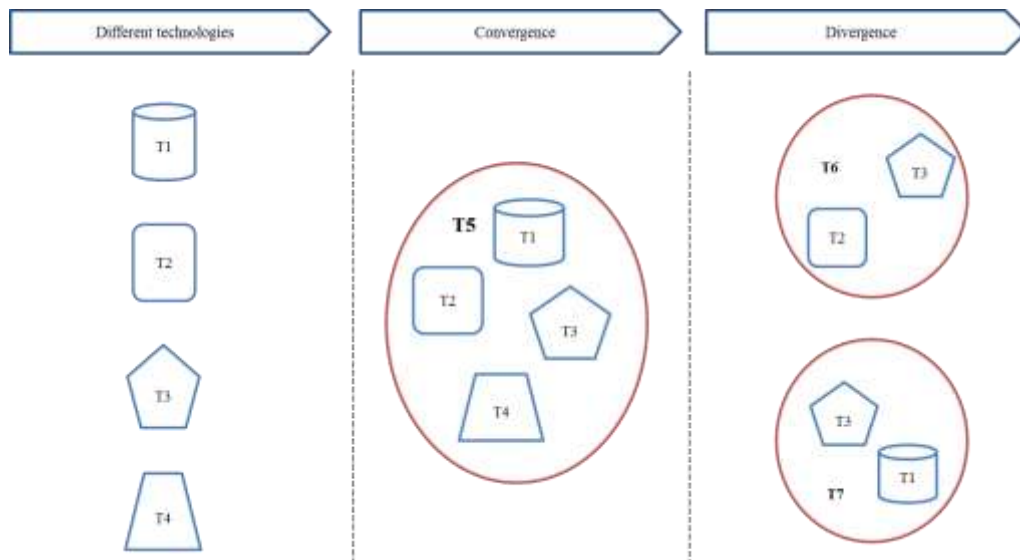
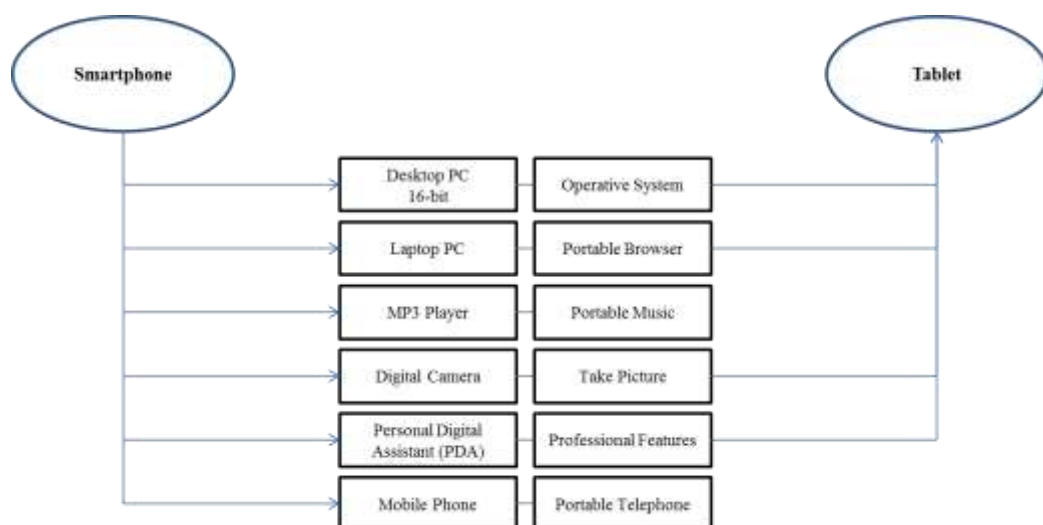


Figure 8 represents how technologies are transformed by three step dynamics. During the first phase there are four different products, or technologies, who respond

to likewise consumer needs. Because of convergence, all solutions are embedded in a new product, the T5 technology. Christensen's (2014) argued that sometimes customers want more specialised solutions able to enclose part of the convergent product but re-modeled in order to respond for peculiar requirement. At this time firms may choose for divergence, defined as a *“reverse process of full or partial disintegration of one product market or industry into one or more new specialised product markets or submarkets. This means that some firms carve out a market by specializing in the provision of functionalities that were previously developed and produced as an integrated part of an end-product or system”* (Christensen, 2014).

Many markets are affected by this concept. Last decades ICT evolution showed a great example for convergence-divergence dynamics because the high modular structure of the technologies employed. Figure 9 takes like example the smartphone market. As early discussed, different technologies merged into a unique hybrid device that is, on global markets, one of the most popular consumer electronics product. It includes technologies useful for their portability (e.g. mobile phone, PDA, Mp3 player and digital camera) and merged them with an operative system, previously limited to static, or prevailing static, products like the PCs. Later, the creation and diffusion of this innovation involved business opportunities for other products.

**Figure 9:** Divergence from smartphone to tablet



Perhaps tablet is the most suitable example of these. It contains only few features of the smartphone, that were mixed to new ones. Larger display made graphic instruments more attractive for customer's needs about reading contents, and browse internet but, at the same time, it reduces the product portability. In fact, if customers want to benefit by a little device to play music during a walk, tablet is not the right choice, whereas smartphone is more appropriated.

The difference between these two devices depends on customer needs, that request different products for specific needs, a sort of market-driven divergence.

Technology divergence and firm's performance are correlated. Smartphone and tablet's global markets have different patterns of competition (Table 4). In fact, only three players are in the top seller position in both markets. Market divergence is acknowledged in customer choices, with an inversion about the market leader. As a result of divergence, tablet seems to be a smaller business than smartphone. A more complex example of divergence was explored by Christensen (2014) about the internet technology security. The author individuated a dynamic of three steps of technology convergence-divergence (Figure 8).

**Table 4:** Comparison of divergent markets in 2014

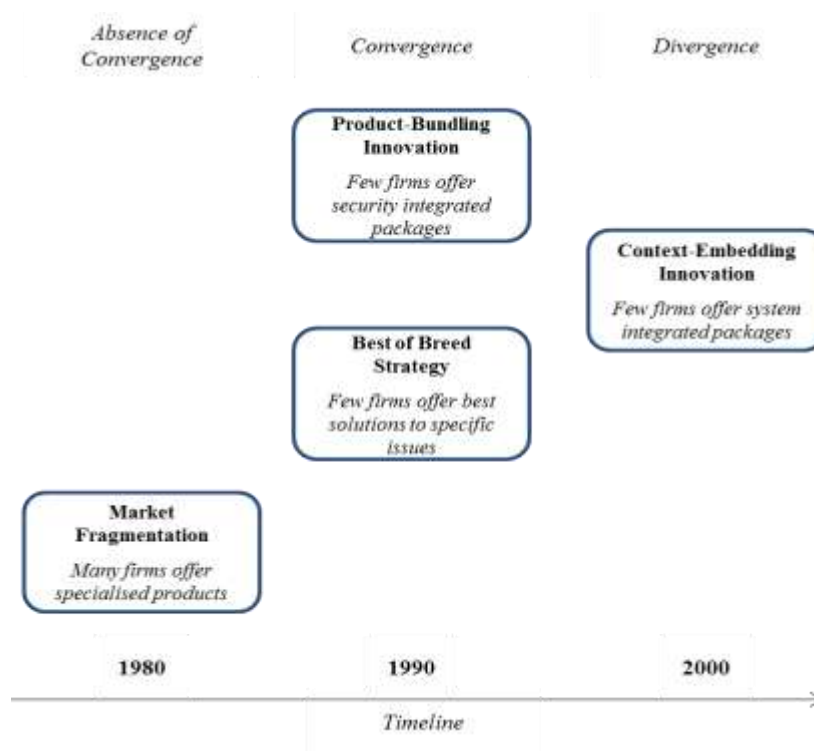
Tablet			Smartphone		
Vendor	Sales (units)	Market Share (%)	Vendor	Sales (units)	Market Share (%)
Apple	70.400.159	36,0	Samsung	299.794.900	31,0
Samsung	37.411.921	19,1	Apple	150.785.900	15,6
ASUS	11.039.156	5,6	Huawei	46.431.800	4,8
Amazon	9.401.846	4,8	LG	43.904.500	4,8
Lenovo	6.525.762	3,3	Lenovo	43.904.500	4,5
Others	60.656.161	31,0	Others	380.249.300	39,3
<i>Total</i>	<i>195.435.005</i>	<i>100,0</i>	<i>Total</i>	<i>965.070.900</i>	<i>100,0</i>

*Source:* based on Gartner dataset (2014).

In a first phase, from the late 1980s to the late 1990s, internet security industry was formed by a multitude of firms specialised in several streams of security oriented technologies, responding to as much customer issues and needs. This decade suggested the Teece's pre-paradigm phase (1989) where a product market was

already not reached. After the 1990, internet technologies began to spread worldwide and internet security followed their success. At the end of 1990s there was a strong industry concentration through product-bundling innovation, in which many and diverse products were acknowledged by user as complementary. Simultaneously, a not professional mass market emerged with a strong preference for commoditised products combined in packages. To respond to this trend, few security specialists evolved into large security integrators in a systemic innovation perspective. McAfee and Symantec began to build security solution aimed to provide a cost reduction and simplification for the users. Other firms as Counterpane and CIPHERtrust, chose the opposite strategy, providing the best solution for each specific issue proposed by the customers. After a path of 291 acquisitions, licensing strategies and alliances, industry was re-designed, from a high fragmented market to few competing firms.

**Figure 10:** Convergent - divergent dynamics in IT security software market



*Source:* based on Open Innovation and Industrial Dynamics: Towards a Framework of Business Convergence (Christensen, 2014).

After the 2000, there was a third phase, in which large firms as Microsoft and Cisco merged the internet security technologies with general IT networks and systems, with a context-embedding innovation, in which antivirus and other security services are incorporated into other products, in a divergent example. This pattern changed the perspective of some theoretical background and involves new relational capabilities that, with the Open innovation paradigm, widely affects the governance relationship of electronics players.

Convergence, or divergence, puts companies to cope with faster lifecycles and stress them to a continuous innovation in a larger line up of technologies.

## **2.2 From Closed to Open Innovation**

Last decades have shown a great revolution for innovation management. Two models are now in clash about the way that permit to develop new products and processes: closed and open innovation. In the present chapter is appointed a comparison between these frameworks.

### **2.2.1 The vertical integration model**

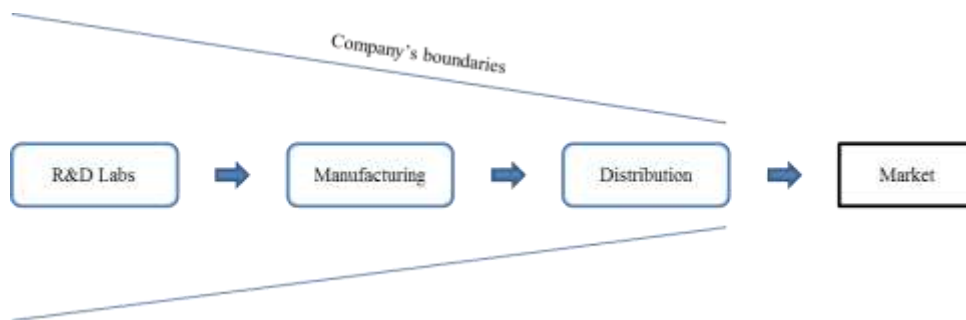
Vertical integration model, also said proprietary model, is a framework employed in the past of innovation management and represent the core pillars under the closed innovation.

At the basis of this framework there is a mono-directional business model (Figure 11), where firms heavily invest in their own internal R&D and the relative knowledge base. Large scale dedicated R&D functions are established with the aim to enhance economy of scale or scope and then produce high barriers to entry for new potential competitors. Accumulated knowledge available into firm's boundaries is the only possible source of innovation, then later will be manufactured and distributed by the company itself (Teece, 1986; Chandler, 1990) in a linear innovative process.

A managerial approach for VIM was well-summarised by James Bryan Conant (2002) with the following statement: *"picking a man of genius, giving him money,*

*and leaving him alone*”. In this interpretation of innovation, firm has to be able in catching the brightest talent in a specific field of technology, employ him and hope that with the sufficient financial support, an innovation will take place successfully on the market (Chesbrough, 2006).

**Figure 11:** The vertical integration model



The financial support includes to provide excellent compensations, resources and freedom to the brightest employees (West & Gallagher, 2006).

Barriers of entry are one of the most important advantage produced, but it involves that large firms, with huge financial resources, are favored in innovation. And, especially in closed systems, the Schumpeter's prevision (1942) about a strong influence by incumbent seem to find a prolific field.

When innovation is wholly enclosed into firm's boundaries it may bring to only two kind of result: a success or a failure. A success is achieved when a new product or service is developed, and the customers buy it on a current, or new, market. However, a vertical integrated innovation request a consistent time expenditure, also years, to become a saleable output, and it sometimes is considered obsolete by the evolving market. Failure at the end of the innovation process is recurring, and can be originated by two kind of errors. The first is the Type I error, which would result when an R&D project, coherent with the firm's business model, become a product, go to market and fail (false positive error). The latter is the Type 2, where the project does not fit the firm's business model, and then, it remain stemmed into the internal knowledge base (false negative error). Type 2 errors show a strong weakness for the proprietary model, because the internal research proponent may decide to develop

the technology on its own, or even more dangerously, to spillover its knowledge and creativity to competitors (West & Gallagher, 2006; Chesbrough, 2006).

Intellectual property management is closed to external sources or, consider them subordinated in respect to internal ideas. In fact, Vertical integrated model suffer of Not Invented Here Syndrome (see chapter 5), in other words “*a negative attitude of employees against externally developed knowledge*” (Hussinger & Wastyn, 2015).

**Figure 12:** R&D output in vertical integration model



*Source:* based on Open innovation: The new imperative for creating and profiting from technology (Chesbrough, 2006).

Closed firms believe that all the useful knowledge are placed inside their boundaries, especially for those organisations already rewarded by market. Also, patents are cumulated in the years, with the aim to avoid litigation costs, showing a defensive approach to IP management (Torrise et al., 2016). Innovation spillovers, are considered like costs and risks, and not as opportunities, even though high tech markets are considerably subject to dissemination of knowledge.

Finally, budget definition usually depends on Net Present Value (Figure 13), that is based on the expected returns and the expected costs of an investment, where these are discounted by a rate that reflects inflation and opportunity costs.

**Figure 13:** IBM’s example of Net Present Value

$$NPV = \text{Initial investment} + \sum_{t=1}^{t=\text{end of project}} \frac{(\text{cash flow at year } t)}{(1 + r)^t}$$

*Source:* based on IBM website (2015), consulted on February 17<sup>th</sup> 2015.

Net Present Value involves that a firm is able to forecast the expected cash flow for its own innovation, but accuracy in such degree of uncertainty is too difficult to be reachable, and as a result the budget definition is compromised.

Finally, summarising the previous literature review the following synthesis (Table 5) highlights the main features about closed innovation.

**Table 5:** Closed innovation main features

<i>Business model</i>	Linear, from R&D to market
<i>Industry</i>	Static environment with marked boundaries
<i>R&amp;D Focus</i>	Attract the smartest employees; More resources are dedicated and more is the innovation output
<i>IP management</i>	Defensive approach aimed to protect internal output
<i>Main advantages</i>	Avoid competition because high barriers to entry

### 2.2.2 The Proprietary Platforms Failure on Electronics Markets

In the past electronics industry was an excellent example of evolution from vertically integrated business models to Open Innovation in a network approach.

The path of development of the modern PC industry has shown the transformation from an economy of scarcity about hardware during the sixties to a more competitive markets about software still ongoing. History began in 1964 when IBM introduced the first successful computing platform, the System 360 with modular architecture and interoperability. S360 reached the largest share of global market, with the exception of Japan, where the IBM's platform was successfully challenged by a stable established from a four firm oligopoly. IBM represented a vertically integrated platform that included processors, peripherals, software and systems.

In 1978 DEC was another example of proprietary platform on the new minicomputer market, and thanks to the VAX minicomputer dominated the US market. Both companies benefited by high barriers to entry because new competitors had to sustain high switching costs and strong R&D expenditure, with application software specialised for each platform (West, 2003). Computer industry was



characterised by a strong concentration led by endogenous sunk costs in rewarding scale (Greenstein, 1999) that won the competition with many new entrants.

The innovation promoted by PC and microprocessors changed the previous industry setting. In fact, microprocessors lowered the cost of entry and was produced only by few vendors. Acknowledged the risk represented by the loss of market control by new entrants, IBM launched a 16-bit version of the traditional PC. 16-bit standard achieved the leadership on global markets. Once again, the only Japan was the exception with the NEC's PC-98 as national leader until the 1995 (Chposky & Leonsis, 1988).

After the microprocessors invention, vertically integrated platforms stopped to exist because product like the PC that included both processor and operative system were supplied from outside vendors. Later, the innovation-imitation dynamics led IBM to lost its leadership in PC industry under the success of new entrants that produced 'clone' computers with the same application software (Langlois & Robertson, 1992).

The 1990s crowned Microsoft as leader in the IT industry, also because the aid supplied by the alliance with Intel. These years was distinguished for the competition game among the Redmond's company and its main competitors such as: IBM, Apple and Sun. As the open systems movement that hit IBM a decade earlier was a reaction to its proprietary model, so the open source software became an attempt to challenge the Microsoft power from its competitors.

IBM, Apple and Sun sought new ways to erode the leader's share of market, and found an answer in globally disseminated open source projects. The first differentiated itself with services, mainframe and midrange systems, avoiding a large competitive pressure.

Apple adopted an opening parts approach, and Sun was revealed as partly open. All these companies suffered the cultural shock to abandon a closed innovation setting. As a result of competitor's behavior Microsoft began to lose its share of market against a larger array of free software developers, and then, early it had attacked the movement in 2001, and later, chose to discover its source to end-user and universities in 2002 (West & Dedrick, 2001; West, 2003).

**Table 6:** Main standards in 20<sup>th</sup> century in electronics computing.

<b>Business model</b>	<b>Category</b>	<b>Year</b>	<b>Firm</b>	<b>Product</b>
<i>Proprietary model</i>	Mainframe	1964	IBM	S/360
	Minicomputer	1977	DEC	VAX
<i>Open standards</i>	16 bit PC	1981	IBM	IBM PC
		1983	NEC	PC-98
		1984	Apple	Macintosh
		1990	Microsoft	Windows

*Source:* based on How open is open enough?: Melding proprietary and open source platform strategies (West, 2003).

From the hardware economy to the modern software and applications, vertically integrated models were abandoned in favor of open systems of innovation. West (2003), suggests to divide the evolution in electronics market (e.g. PC) in three different phase:

1. Proprietary platform: Few industry pioneers were vertical integrated because they needed to establish high barriers to new entrants. The main market feature was the standard itself.
2. Open standards: Buyer demands and new entrants forced incumbents to incorporate standards that were share with others competitors. Competition increases and no firm kept the whole supply chain control.
3. Open sources: Firms disclose technologies (e.g. source code) and develop strategies that permit to increase their ability to appropriate the returns. Open sources may be more offensive opening parts and maintaining full control of some components that offers greater opportunities for differentiation, or may be partly open maintaining such restrictions.

### **2.3 Open Innovation Processes**

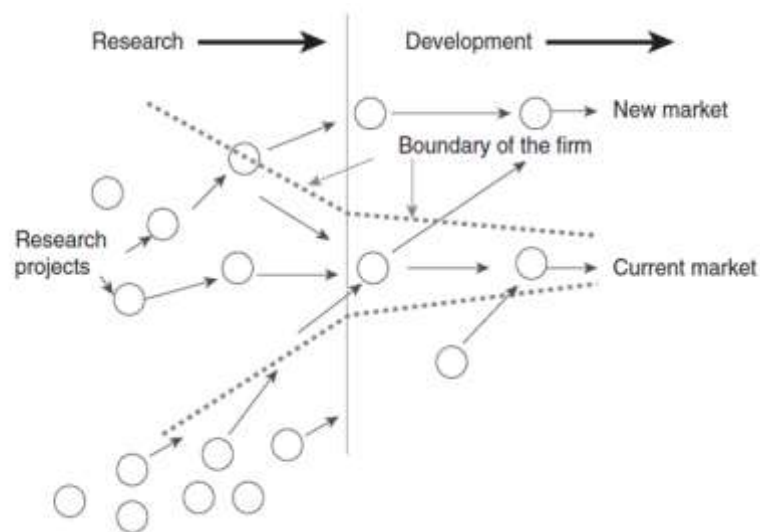
An increasing number of firms, from different geographical areas such as IBM, Panasonic, Cisco System, Lego Group and Lenovo, chose to empower their own business models because a re-engineering of the innovative process. Innovation

literature in this matter evolved, stretching from the United States definition of Open Innovation (Chesbrough, 2003) to another shades of the same, more suitable with the Asiatic economies, based on an inference from the network research streams about *chaebol* and *keiretsu* (Lee et al., 2010). At the basis of the openness approach there is a multi-directional business model (Figure 14), that consider on one hand, internal and external sources of innovation at the same level, on other hand, the likelihood to sell innovation output on customer, or on technology market.

There are several push factors that bring firms to adopt an Open innovation. Early adopters aimed to response to an internal lack of capabilities or knowledge, that was overcome with an external environmental screening. Firms without peculiar expertise in different technologies decided to activate outside-in processes for access to external skills and knowledge, aiming to an external technology exploration strategy (Raisch et al., 2009; Mortara & Minshall, 2011).

Howells et al. (2008) suggested some features about access to external knowledge such as: cost reduction, time compression and sharing risk. These three motivations explained how the firm needs to establish outside-in processes and, sometimes, R&D outsourcing. However, Open innovation is based even on inside-out processes, and the previous factors not explain why firms have to put their technologies on market.

**Figure 14:** Framework for an open business model



*Source:* Open Innovation: The New Imperative for Creating and Profiting from Technology (Chesbrough, 2003).

Dahlander and Gann (2010) answered to this issue splitting the inside-out processes into two macro-categories: selling and revealing (Figure 15). The former are originated from the aim to profit by technologies that are incoherent with firm's business model, whereas the latter are explained from several indirect motivation as marketing or setting standard.

**Figure 15:** Open innovation processes

	<i>Not Pecuniary</i>	<i>Pecuniary</i>
<i>Inbound</i>	<b>Sourcing</b>	<b>Acquiring</b>
<i>Outbound</i>	<b>Revealing</b>	<b>Selling</b>

*Source:* How open is Innovation? (Dahlander & Gann, 2010)

Finally, Open innovation involves also a strong barriers to adoption that is mainly acknowledged as the cultural implementation of new innovation processes (van de Vrande et al., 2009). Cultural impediments are mainly the Not-Invented Here and the Not Sold Here Syndromes, that will be deepened in the chapter 5.

### **2.3.1 Innovation and Market-driven Management**

The factors that pushed the adoption of Open innovation brought firms to develop outside-in processes well before than the inside-out. However not all firms adopted them in the same period, in fact, market pressure forced hi-tech players to develop openness before than others. Electronics (Christensen et al., 2005) and telecommunications (Ferrary, 2011) industries were pioneers in this field, even before the theoretical diffusion of the Chesbrough's paradigm. Mortara and Minshall (2011) suggested, with the aim of a matrix, a cultural framework in which innovative firms may be placed when they try to implement Open Innovation.

They listed four implementation approaches:

- *OI conscious adopters*: firms who adopted mainly outside-in processes to access in external opportunities and capabilities, in an external technology exploration perspective. OI implementation rely on top managers who have the objective of the diffusion of the paradigm inside the firm, thanks to the dissemination of languages and information about openness. These firms started with this paradigm because the diffusion of the Chesbrough's studies, and sometimes, are helped by specialised intermediaries.
- *OI ad hoc adopters*: firms who adopted outside-in processes as a result of a cost-reduction imposition by market. There isn't a strategic plan to implement the paradigm. Industries as aerospace and defense depends on public funding, and when these decrease firms have to find new way to make R&D cost-effective (Kerr et al., 2008).
- *OI precursors*: firms who adopted OI because market hyper-competition forced them to reduce time and costs of the innovative process. The disposition of these markets favor the development of business models based on coupled processes of innovation (Enkel et al., 2009), aimed to draw synergies by the integration of internal and external technologies. Pioneers as Lucent, Cisco, Texas Instruments and Oracle were important contributors to the OI previous studies. These firms are well-positioned in a proactive network able to take advantage of both inside-out and outside-in processes.
- *OI communities of practice*: firms who have a previous experience of openness leaded by R&D partnerships, and later try to get top management aligned for push a culture of openness from the highest levels.

Mortara and Minshall's framework about the Open innovation implementation may be integrated with the organisational change highlighted by Chiaroni et al. (2011) in the Italcementi case. The authors suggested three step of evolution about firm's openness into the innovative process. In particular were deepened the following phases:

- *Unfreezing*: the moment in which firm's top management choose to adopt an OI approach. Unfreezing seems to be approximated with the 'OI conscious adopters'. A this time firms accept the organisational change and prepare

themselves to a new way to reach innovation. Italcementi had hired a new head for R&D unit and established the Intellectual Property Office. Openness is already a goal rather than a result.

- *Moving*: a time lag in which firms invest in new routines and projects aimed to enrich their knowledge management. In the Italcementi case there was the TX Active project. Network starts to become more important and a set of relationships will be established with several partners. Disposition and duration of the relationships, as well as the partner, rely on firms goals, needs and dimension.
- *Institutionalising*: in this last phase network has a stable structure as well as the partnerships with other sources of innovation. Firms have recognised routines and processes that are suitable with their needs and OI is achieved. Italcementi achieved the present phase with a strong commitment in customer engagement (Innovation directorate), competitor relationships (Competitors group) and research (Kilometro Rosso scientific park).

Open innovation culture may be aligned with the Market-driven Management because many points of contact emerged between these two research streams.

Day (2001) suggested three drivers for Market-driven firms, such as: the role of culture, capabilities and configuration. These drivers are coherent with some innovation management's key factors (Table 6). The author argued a firm's competitive advantage when it is able to focus on market, both in customer and in competitor perspective, and avoid the arrogance to be exclusively technology-driven. A market-driven firm has to establish an organisational configuration based on strategic focus on market, coherence of elements and flexibility. In fact, both Day and Open Innovation literature considered Cisco System a successful organisational example.

Open innovation's networks are based on two kind of processes, that can be assimilated to Market-driven Management capabilities: outside-in and inside-out (Day, 2001; Gatti & Cesareo, 2012). Outside-in processes are not a novelty in innovation management, but in the past, it wasn't so articulated as after the diffusion of Open Innovation in academic literature. In fact, firms can successfully integrate their own internal resources with those offered by other supply chain members such

as customers or suppliers, by extending the locus of innovation across organisational boundaries (Fritsch & Lukas, 2001).

**Table 7:** Market-driven quotes tied to innovation management

<b>Capabilities</b>	<p><i>“The market-driven organization has superior capabilities in market sensing – reading and understanding the market. It also has superior capabilities in market relating – creating and maintaining relationships with customers. Finally, the market-driven organization has capabilities in strategic thinking that allow it to align its strategy to the market and help it anticipate market changes.”</i></p>
<b>Culture</b>	<p><i>“Contrast Motorola’s aloofness with the behavior of John Chambers, the CEO of Cisco Systems, the networking giant that provides the routers, hubs, and switches that make the Internet feasible. He is passionate about avoiding the arrogance that makes technology-driven companies unresponsive to their customers.”</i></p>
<b>Configuration</b>	<p><i>“Markets change, so the configuration should not be a straitjacket that inhibits trial-and-error learning and continuous improvement. The challenge for a market-driven organization is to devise a structure that can combine the depth of knowledge found in a vertical hierarchy with the responsiveness of horizontal process teams.”</i></p>

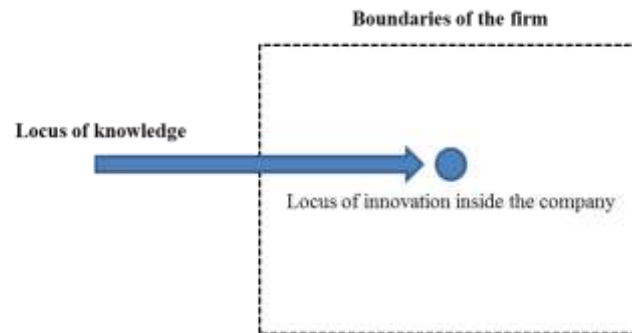
Source: based on Market-Driven Winners (Day, 2001).

Outside-in processes consider firms as the recipients for fluxes composed of technologies, information and ideas (Figure 16). In fact, scholars suggested a separation between locus of knowledge creation and locus of innovation. The first is placed inside the source, for example a new idea from a customer, or a basic technology from a university. The latter is placed inside the firm and depend on the ability of integration among the external knowledge and the internal ones.

Some low-tech firms consider outside-in processes as crucial when they expect spillovers from higher tech industries such as firms producing microprocessors in automotive (Gassman & Enkel, 2004).

Dahlander and Gann (2010) divided outside-in, also called inbounding, processes into two categories: sourcing and acquiring.

**Figure 16:** Outside-in process



Finally, market-driven management and open innovation are close together research streams. The processes configuration and the cultural dimension are prevailing as points of contact. In the following sections will be deepened the Open innovation processes, while in the chapter 6 the market-driven management studies will be considered in the network dimension about innovation management.

### **2.3.2 Sourcing Processes**

Sourcing refers to how firms can use external sources of innovation. In fact they have to scan the external environment prior to initiating their own internal R&D activity.

The increasing interest in sourcing have two reasons. First firms have a growing awareness that important locus of knowledge is beyond their boundaries, then they are employing increasing proportion of external sources of technologies during their R&D process (Hagedoorn, 2002). Second, due to intense competition and increasing complexity of the technological environment, it is fundamental for firms to explore knowledge available outside their boundaries, because they find difficult to maintain research efforts simultaneously along all technology fronts (Hsu, 2005; Luo et al., 2007).

According with Freeman (1974), R&D laboratories are able to absorbing and assessing external ideas and make them fit with internal processes. Search strategy is the basic pillar of Open Innovation, because openness is a direct effect of the number of sources that a firm establish (Laursen & Salter, 2004). Sisodiya et al. (2013) found that a positive relationship between firm performance and open innovation is



enhanced by a firm's ability to engage effectively in boundary spanning with other organisations.

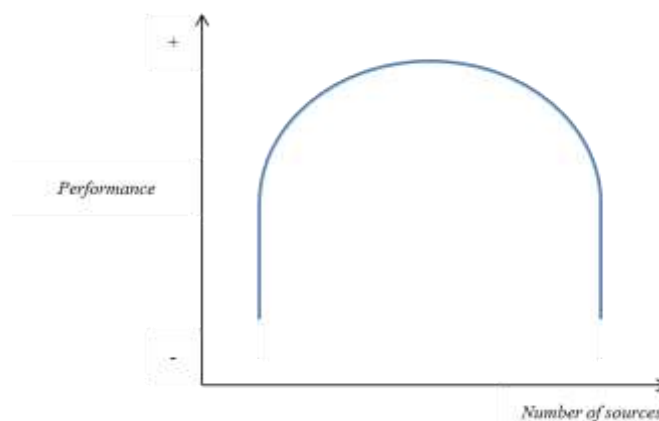
Despite the advantages of sourcing, there are many reasons for making attention in its risks. In fact, there are cognitive limits to how much firms can understand and absorb (Figure 17). In fact, the breadth for sources of innovation is curvilinear related to innovative performance (Laursen & Salter, 2006). Technology sourcing may lead to over-dependency on external locus of knowledge, augment in coordination costs and functional mismatches. As a result external dependence involves a gradual loss of internal innovation capabilities (Xu et al., 2012).

External technology sourcing is useful in the following conditions (Gassman & Enkel, 2004):

- a firm lacks internal resources;
- an external source has a better technological position;
- knowledge can be easily transferred and market barriers are low.

In refer to the third condition is appropriate to highlight the difference between tacit and explicit knowledge on sourcing processes: explicit can be more easily transferred among different organisations whereas tacit knowledge is mostly developed internally and is difficult to manage (Liebeskind, 1996).

**Figure 17:** Relationship between innovation source and performance



*Source:* based on Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms (Laursen & Salter, 2006).

A detailed study about several kind of sources will be done in following section (chapter 5). Table 8 shows the possible sources of innovation that a firm may consider in its network.

**Table 8:** Main sources in innovation networks

<b>Source</b>	<b>Research Streams</b>	<b>Degree of Heterogeneity</b>
<i>Universities</i>	U-I relationship	Medium – High
<i>Customers</i>	User innovation, crowdsourcing	High
<i>Start-up and SMEs</i>	Network, strategic alliances	Medium
<i>Competitors</i>	Co-opetition, strategic alliances	Low

Each source has own characteristics and may be more or less similar to the focal firm. According to firm’s needs and goals there are several degree of involvement into its strategy.

### **2.3.3 The Complementary Effect**

After the source screening, firms have to manage the knowledge transfer from the source into its own boundaries. This process is called ‘acquiring’ and represents all the activities that are necessary for absorbing external knowledge. Acquiring processes are strictly correlated with the research stream about absorptive capacity (Cohen & Levinthal, 1990) that showed how firms can optimise the way to internalise the R&D efforts of other organisations.

Absorptive capacity starts from the premise that prior knowledge increase the ability to reach and use new knowledge. Then, benefits from outside-in processes request expertise in assessment and integration of external ideas (von Zedtwitz & Gassmann, 2002).

Primarily Cohen and Levinthal (1990) distinguished learning capability and problem solving. The first involves the capacity to assimilate existing knowledge while the latter regards the creation of new knowledge. Learning capabilities have a cumulative expression: learning performance increases when people already knows something about the problem and finally a team with different backgrounds make easier innovation. Another important key factor refers to organisational absorptive

capacity built on a synergy between more individual absorptive capacities of the firm's employees. At the firm-level, as Cohen and Levinthal stated, absorptive capacity can be generated in a variety of ways: by investing in R&D, as a by-product of a firm's manufacturing operations or by sending employees for advanced technical training (Spithoven et al., 2011). Several authors stretched or modified the original theory with emerging issues. Zahra and George (2002) reviewed the literature on absorptive capacity and redefined it as a set of organisational routines and processes. Behind this idea there is a significant variation in the social interactions elements, therefore, affected by the interplay of social integration mechanisms. Vanhaverbeke and Cloudt (2014) linked absorptive capacity literature with the understanding of new organisational routines to tap more effectively into external knowledge. There has been increasing critiques on this operationalization of absorptive capacity (Spithoven et al, 2011), nevertheless the need for a managerial application of the theory bring to this path of development. In absorptive capacity theory the answer to company's need for external knowledge is the development of a stronger in-house R&D, thanks to the firms will be able to catch the technological opportunities. Starting off from the premise that many firms operating in traditional industries lack absorptive capacity while large, R&D intensity firms have higher skills in these domains (Spithoven et al., 2011). Cohen and Levinthal in 1990 defined absorptive capacity like the collective expression of an *"ability to recognize the value of new information, assimilate it, and apply it to commercial ends"* and in particular the authors argued that *"the ability to evaluate and utilize outside knowledge is largely a function of the level of prior related knowledge"*. The ties between external and internal source of innovation became clear because absorptive capacity is related to an evaluation of knowledge available only out of the firm's boundaries and the focus on it does not diminish the need to understand how firms can generate and manage their in-house R&D (Gambardella et al., 2010).

In order to acquire their partners' contributions, the network members should have similar knowledge bases, but there should also be few differences in order to allow for mutual learning. In fact, a firm must choose its partners so that they represent a large array of complementary skills, but redundancies are minimised (Enkel, 2010). The more relevant the network's activities are for the member organisation, the

higher the investments will be in absorptive capacities and, consequently, the knowledge/experience transfers between the network and the focal firm (Enkel, 2010).

Returning on the innovation literature, scholars have understood since the 1970s that sources of innovative ideas come from outside the firm (Freeman 1974; Achilladelis et al., 1971; Rothwell et al., 1974; Gibbons & Johnston, 1974). In particular inbound mode has been far more popular among researchers than the outbound mode and this may also relate to its greater popularity among managers, either as a cost-reduction or because more firms are in position to use technology than to create it (West et al., 2014).

Open innovation is based on the exploitation of the external source of innovation but surely it doesn't mean that internal R&D is not crucial. Global markets reward firms that achieved success with research of others because external sources of technology into a company's innovation process increases the number of possible sources of innovation (Chesbrough, 2004). In fact there are some factors for which is important consider a complementary effect between internal and external source of innovation (Dahlander & Gann, 2010). Firstly, there is a cost observation because internal R&D can bring to gain economies of scale and scope (Henderson & Cockburn, 1996). Secondly, there is a relational benefit when knowledge and expertise engender a ticket of admission to potential partner. Firms with a better reputation are more attractive for possible partnership (Rosenberg, 1990). Thirdly internal R&D create the absorptive capacity that can track and evaluate development outside firm boundaries. High investment in R&D will benefit the spillover (Cohen & Levinthal, 1990). These three causes explain a complementary effect to openness while a substitution effect emerge only if firms need to compensate a limited internal R&D focus (Dahlander & Gann, 2010) and in this sense also the crowdsourcing dimension find a own logic.

More in particular, the concept at the heart of the outside-in side of Open innovation is the right balance between sources and the relative integration (Enkel et al., 2009).

If we consider the three different archetypes proposed by Gassman and Enkel (2004) for Open innovation such as outside-in, inside-out and coupled process, we

must underline that absorptive capacity can match their basis only for the first kind of process.

**Table 9:** Comparison between complementary and substitution effects

	<b>R&amp;D Outsourcing</b>	<b>Open Innovation</b>
<i>R&amp;D costs</i>	Limited internal efforts in R&D	Strong internal efforts in R&D
<i>Focus</i>	Acquisition of a technology	Integration of internal and external knowledge
<i>Absorptive capacity</i>	Scarce absorptive capacity	Strong absorptive capacity
<i>Effect</i>	Substitution effect	Complementary effect

Hence, the theoretical framework about absorptive capacity is well fitted with the outside-in perspective of the Open innovation, but it is inadequate to explain the others dimensions (Vanhaverbeke & Cloudt, 2014). Once clarified the importance of absorptive capacity in outside-in flows of knowledge is necessary the analysis of its functioning like a theoretical instrument for understanding outside-in processes.

The diffusion of the Open innovation's paradigm puts the focus on a new wave of interest for a managerial approach and this underline the needs for metrics and standardised routines in which literature point of view can be turned into firm's structure. As a result, both for the original version and the recent development, absorptive capacity is a valid theoretical framework for outside-in processes of Open Innovation (Vanhaverbeke & Cloudt, 2014), and it represent a strong aid for understand the importance to consider the external source management only like a complement of the internal investment.

In basic research, when the aim is to discover something truly new, neither the problem nor the domain is well defined, then several organisations prefer work through grants and academic affiliations rather than to invest in large-scale research (Kadar et al., 2014).

Identify knowledge is not enough, ideas will be acquired and integrated to existing knowledge (Chesbrough, 2003) and usually there is only a small niche of employees who possess the technical expertise and personal interest to regularly perform this task (Whelan et al., 2011).

The complementary nature of the internal and external knowledge processes underscores the firm-level coordination requirements, which call for an integrative knowledge management (Cassiman & Veugelers, 2006). A firm needs to successfully reconfigure, thanks to absorptive capacity, and realign its knowledge management capabilities to adapt to changing environmental conditions better and sooner than its competitors (Eisenhardt & Martin, 2000).

#### **2.3.4 Technology Licensing**

Although outside-in processes are largely studied by innovation literature, inside-out ways to exploit the R&D efforts are not so well spread in academic research.

As Lichtenthaler (2009) stated, outbounding processes “*refers to outward technology transfer, and it suggests that firms can look for external organisations with business models that are suited to commercialise a technology exclusively or in addition to its internal application*”.

If a firm wants to adopt the Open innovation paradigm, it has to control both the typologies of process. Enkel et al. (2009) suggested that the highest level of openness is reached only when firms implement the coupled process, that is a integration between outside-in and inside-out. Coupled process is based on the co-creation with several partners through alliances, cooperation and joint venture, of a give-and-take relationships. In fact as many sources are in the left side of Chesbrough’s funnel, as many may be the external technology commercialisation channels (Christensen et al., 2005; Lettl et al., 2006).

Inside-out processes are particularly complex because involve several appropriability and IP management issues. In fact firms fear the impossibility to reach sufficient benefits from the exposure of its innovation and then, in an innovation-imitation context, a better positioned competitor that are more able to capture profits from it (Helfat & Chesbrough, 2006). Teece (1986) argued that regimes of appropriability is one of the three building blocks to consider for profiting from innovation. The author stated that appropriability “*refers to the environmental factors, excluding firm and market structure, that govern an innovator’s ability to capture profits generated by innovation*”. On global markets, to protect an

innovation is a very hard concern. In fact patents are ineffective to safeguard process innovation and, also for product innovation, the costs for upholding their validity and proving their infringement are high. In innovation, imitation management represents an imperative for firms that compete in global markets, where in many industries there is an accelerated crisis of older forms of industrial organisation (Brondoni, 2012; Dunning, 2008). The Chinese way to pursue innovation is an example of how firms avoid breakthroughs and invest in accelerating time to market, emulating product lines, launch initial versions and collect user feedback to improve the products, showing high degree of flexibility (Williamson & Yin, 2014).

Modern innovation enclose the awareness that competitors are fast and effective in draw the profit of the first mover, who can dies in its youth (Golder & Tellis, 1993). In the past, start-up as Compaq, Oracle and Sun, with a growth rate over the 40% in a year, reached the market position of historical incumbent (Jager, 1999).

After these premises, why a firm should expose itself with inside-out processes? A first hypothesis is profit.

**Table 10:** Examples of innovation - imitation dynamics in electronics

<b>Technology</b>	<b>First-Mover</b>	<b>Dominant Player</b>
Graphical interface	Apple	Microsoft
PDA	Apple	Palm
Browser	Netscape	Microsoft
Web search engine	Excite, Lycos	Google

*Source:* based on Profiting from innovation and intellectual property revolution (Pisano, 2006).

The main example was IBM that in 2000 accounted for 20% of its net income, thanks to a 1,7 billion of USD from technology licensing (Kline, 2003). However not all firms are able to profit by licensing and, further there is a strong gap among successful pioneers and unlucky others that showed great difficulties in technology selling activities.

Lichtenthaler's (2007) empirical study showed an analysis of possible motivations for corporate licensing, and observed that firms considered the following reasons as the most important:

- freedom to operate;
- access to knowledge;

- realising market entry;
- ensuring technology leadership;
- selling additional products;
- setting standards.

Several motivations are technology-oriented, that means who firms aim to strengthen their technological position. A further clarification is the concept of 'freedom to operate' that concern about the opportunity to assure cross-licensing agreements in which firms mutually exchange patents and knowledge. Kutvonen (2011) added a further classification and listed three strategic mixed objectives from out-licensing:

- realising learning effects;
- enhancing the firm's reputation;
- strengthening the firm's network.

The author suggested that doing technology transfer, firms may increase their ability to practice Open Innovation, both in outside-in and in inside-out processes, with a compression of the firm's learning curve. The other two goals are strictly tied with the capacity to attract more and better partners showed by firms with a strong reputation (Rivette & Kline, 2000). Both the aforementioned classifications put emphasis on product considerations. In fact, there were cases of companies who used out-licensing to maximise the penetration of their technologies in the market such as Motorola with the GSM standard (Kline, 2003), Canon with laser jet (Koruna, 2004), and Xerox with electrofax (Chesbrough, 2002).

Thus, profits is not the first direct and perceived benefit from selling a technology. However out-licensing represent a part of firm's strategy, that choose to commercialise unused technologies (Fosfuri, 2006) and distinguish itself from closed innovators that have a limited return on their R&D expenditures, tied on the final success on market. Obviously selling technologies may weaken the firm's competitive position. Many environmental variables influence the inside-out processes outcome (Lichtenthaler, 2009; Arora et al., 2001). If firms are in a static environment, they may achieve strong advantages in protect an innovation with a patent and keep it into their boundaries, but in a high technology obsolescence context, as in electronics, the possibilities to capture value from this behavior is



marginal (Levin et al., 1987). In dynamic industries Open innovation became a great option to avoid the dramatic loss of value regarding a new technology, and the possibility of achieving a higher return on R&D efforts, only with an internal use of them, are reduced if technology change quickly. As a result outbound processes increase when technologic pressure is at the highest level (Gambardella et al., 2007). But also in these situations firms need to be safeguarded from the risk to sell the corporate crown jewels (Fosfuri, 2006) because to sell a technology is more dangerous than sell a product.

Historically there were many examples of out-licensing failure. In the automotive industry the Kearns' case in the early 1960s supplied an anecdotal evidence of the difficulties tied to out-licensing. Robert Kearns is the independent inventor of the intermittent windshield wiper (Seabrook, 1994; Gans & Stern, 2003). He proposed his technology to Ford Motor Company, disclosing during the negotiation many fundamental operative principle of his invention. As a result, Ford not accepted to buy the proposed technology and, few time later, introduced a similar one on the market. Only in the 1990s Kearns upholding his patent, was able to capture an economic return. At the same way, software firms compete in a more dangerous environment, where for selling a code is necessary disclose a great portion of its functionality. Moreover, software are characterized by high imitability and reduced copying costs (Kutvonen et al., 2010). The most habitual litigations on patents between electronics giants as Samsung and Apple, don't reduce the important role of the patent as a cross-licensing facilitator. Technology transactions are simpler when firms trusted in a solid IP protection, and patent is one of the most diffused related instruments (Yang & Kuo, 2008). In fact, patent protection enhance inside-out processes because represent a positive incentive to capture benefits from technology transfer.

Out-licensing is an advanced way to implement inside-out processes. A less invasive solution is to establish a contract of R&D consulting with a partner, in which an innovation remain isolated into the organisational boundaries of the innovators. Instead, in out-licensing firms lose their control on innovation for a pecuniary return in a technological asset oriented mode (Stankiewicz, 1994).

Another dimension of interest in licensing is the timing, defined as “*the stage in the technology life cycle at which the licensing takes place*” (Ford & Ryan, 1981). Pharmaceutical industry is a peculiar example of an early licensing in which firms begin the process 3-5 years before the new product is introduced on the market. According with the organisational structure of the licensor and the timing, there are two kind of licensing (Kollmer & Dowling, 2004):

- vertical agreement: licensor sell the technology to a not-competitor licensee because it doesn't operate further downstream of the value chain.
- horizontal agreement: licensor sell the technology to a competitor licensee that operates at the same level of the value chain.

The choice between vertical and horizontal agreements may depend by the firm. SMEs usually has not sufficient marketing and financial resources to commercialise their product in full autonomy. Scarcity of internal resources and limitation in their employment push firms to search alternative ways to commercialise products in external environment (Keupp & Gassmann, 2009). Several studies deepened the correlation between firms with a lack in complementary assets and networking tendencies with the aim to describe Open Innovation relationships (Birley & Norburn, 1985; Edwards et al., 2005; Macpherson & Holt, 2007). In SMEs perspective, especially for start-up, external exploitation may act as a core business model (Kutvonen, 2011).

Both vertical and horizontal agreements involve a cooperative behavior in which firms decide to collaborate on the basis of a technology, object of interest. Licensing occurs when the firm who has the technology think to achieve the right price for it. Licensor may sell its technology to one or more licensees. After the agreement, licensees have the right to exploit the innovation in exchange of a fixed fee, or a more complex payment setting. Also, partners may set a technical assistance clause because technologies usually involve high competencies in the implementation phase (Gans & Stern, 2003). According to the complexity of out-licensing, many firms are employing pre-commercialisation activities, defined as “*activities aiming towards the successful commercialization of a technology or knowledge asset, either internally or externally, that are performed prior to the actual active*

*commercialization phase*” (Kutvonen, 2011). Lichtenthaler (2007) argued that external technology exploitation is a process based on five different steps:

- planning;
- intelligence;
- negotiation;
- realization;
- control.

In a very imperfect environment pre-commercialisation activities as planning, intelligence and control, are pivotal to ease a successful out-licensing, and avoid mistakes in the partner selection.

However licensing involves high risks and it is a complex process to manage. There are some factors that maximise the success for this outbounding process and many of them are strictly tied with the internal dimension with particular attention to the employees. According to a research conducted by the MIT Sloan Management Review (Lichtenthaler et al., 2011) a pivotal role is played by the assignment of responsibility to the employees as the creation of teams focused on the opportunity identification in specific technology fields. Then, a further team have to be employed in the technology transfer. Many firms have a technology transfer office (TTO) aimed to optimise the technology-revenue exchange thanks to the help from R&D experts, marketers and attorneys. Another important role is played by the executive champion that have the task to promote the technology licensing throughout the organisation, challenging the not sold here syndrome. At an inter-organisational level, licensing is a more successful strategy for those firms that are able to cooperate with a network (Lichtenthaler et al., 2011).

The same research identified four groups of behavior perpetrated by the firms as:

- Traditionalist: who is focused mainly on the protection of own intellectual property and see the out-licensing like an occasional situation, in a closed innovation perspective.
- Hesitator: who is conscious about the licensing benefits but doesn't have the right cultural or organizational dimension able to reach those advantages. Licensing remains an occasional situation, mainly the answer to external stimulus.

- Activist: who puts an increasing attention in how develop own inside-out process. Activists established technology transfer offices, and give a managerial emphasis to catch the opportunities on several technology markets.

- Outperformer: who consider licensing as a strong contributor to the firm's performance. Outperformers have a long run history of inside-out process, and a larger part of employees are involved in the aforementioned teams. These firms were the pioneers in this processes and their organisations have developed routines to manage the complexities tied with them.

The MIT research (2011) revealed that outperformers are rare examples, while the 74% of its sample was composed by hesitators and traditionalists.

Finally, both licensor and licensee may have benefits from licensing. The former avoids sunk costs tied to establish complementary assets while the latter reduces the cost of explorative R&D projects or investment in those imitative research useful to compete with innovative new entrants (Gans et al., 2000).

### **2.3.5 Revealing and Open-Source Software**

In many global markets, firms don't employ licensing strategies for their own technologies, but consider to free reveal them to other market actors. Free revealing means that *"all intellectual property rights to that information are voluntarily given up by that innovator and all parties are given equal access to it and the information becomes a public good"* (von Hippel & von Krogh, 2006). In the mapping of processes suggested by Dahlander and Gann (2010), revealing is an outbounding, not pecuniary process that deals with how firms disclose internal resources, without a direct financial reward but in the prevision of future indirect benefits.

Free revealing may entail both new technologies and intellectual property that are early protected by patents. IBM was a pioneer also in this inside-out process, because revealed to users and suppliers its technological advancement in the semiconductor manufacturing, when substituted the aluminum interconnections among circuit elements with the new copper alternative (Lim, 2000).

However revealing is not a free to cost way, and actors that will benefit from such intellectual property have to sustain costs as the venial subscription to a website or a

journal, or a more expensive investments in complementary assets that are necessary for managing new innovation input (Cohen & Levinthal, 1989; Teece, 1989; MacKenzie & Spinardi, 1995).

There are three models that explain how the innovator can capture profit from its innovation.

The first is the private investment model in which the innovation is the effort made by a private investor that protect his novelty with patents, copyright and trade secrets (Figure 18).

**Figure 18:** Private investment process



The protection, and the following commercialisation is the main way to obtain a private return. Innovator acts as a monopolist, and society suffers the social loss because it increase the innovators' incentive to invest in R&D (Arrow, 1962; von Hippel & von Krogh, 2006).

This model is strictly near to closed innovation, in which value capture depend only on the firm's ability to protect the new knowledge and commercialise it, with a strong emphasis on first-mover advantages.

The second model is the collective action (Figure 19) in which innovators cede the control of its knowledge to other subjects and transform it in a good defined by non-excludability and non-rivalry as a public one (Olson, 1967). Social loss is avoided because society has an access to knowledge. The strong limitation to this model is the free riding issue tied to the public goods, because some actor may act in an opportunistic behavior. Obviously, the positive contribution in the innovation is awarded with a positive incentive. Science is an example of collective action where researchers may absorb knowledge by journal and conference (outside-in process) and create something new to share with their colleagues (inside-out). In the case of science, researchers have a reputation and career benefit.

The first documented example of collective inventions was the Cornish pumping engine development. As deepened by Nuvolari (2004) in the 1811 a group of mine managers began to publish a monthly journal about operating principles and

performance of engines. Richard Trevithick and Arthur Woolf invented a high pressure engine and decided to don't patent it. The invention was promoted on the journal and every engineer had access to the new technology. As a result the efficiency of Cornish engines reached high level of development thanks to the information shared among professionals. The main goal of the journal were accomplished, because the publication allowed a large scale diffusion of best technics, and engineers were put in a competition in their capabilities to improve the engine. High degree of knowledge sharing, massive improved the rate of technological advance. Allen (1983), a pioneer in this research stream, argued three essential features that played as incentive for the collective inventions:

- technological change are characterised by incremental innovations;
- firms must be inclined to make publicly available sensible technical information about their technologies;
- firms used the sharing knowledge base in order to improve the technology.

All the features argued by Allen may be observed on the software development.

**Figure 19:** Collective invention process



Private investment model and collective action are the two ends of the innovation value capture as the theoretical closed and open innovation. However, firm usually choose an intermediate position because the likelihood to moderate the model's negative effects. In this sense von Hippel and von Krogh (2006) proposed the private-collective model as a hybrid strategy that is more suitable than the previous with the case of Open Source Software. In fact, electronics is the best industry to study in revealing pattern because the richness of Open Source projects such as Linux, Apache and MySQL, that were popular examples of the practice (Villaroel et al., 2013).

A firm following the private investment consider free revealing as a danger, in which it hasn't the benefit guaranteed by the protection of the innovation, whereas a firm that trust in collective invention has the issues related to the free-riders. In OSS individual benefits is tied to participation in communities where the projects are discussed and, this is an opposition to the free rider behavior (von Krogh et al., 2003). In the private-collective model, private benefit to innovators who freely reveal are higher than to free riders because contributors may obtain private rewards linked to the development of that product. However in OSS there aren't any contractual guarantees of obtaining innovation, but only informal development collaborations (Feller & Fitzgerald, 2002). In fact, many firms prefer to keep some line of code in secret and protect part of software in order to permit a future profit by commercialization.

Henkel (2006) argued that in the case of embedded Linux, firms reveal on average about a half of their code, even if the better external development support is reached with high level of revealing.

The literature about OSS suggested the following advantages about free revealing (Dahlander & Magnusson, 2005; Lerner & Tirole, 2002; Henkel, 2006):

- benefiting from external support by communities, other organisations and users;
- setting an industry standard that safeguard the interoperability among codes;
- increasing demand for complementary products;
- increasing or creating firm's reputation in the industry, and showing the participation in the Open Source global initiative.

The same literature listed the following caveats:

- the code's early innovator may lost the control of the future development of the product;
- the sales achieved by software commercialisation may be reduced because users are able to find it freely.
- all parts of code who are revealed may be adopted by firm's competitors with a better positioning or complementary assets around their innovation process.

**Table 11:** Comparison between innovation models

	<b>Private Investment</b>	<b>Collective Action</b>
<i>Access</i>	Restrict access to knowledge	Open access to knowledge
<i>Focus</i>	Protect knowledge by external players	Distribute knowledge across boundaries
<i>Output</i>	Private good	Public good
<i>Main benefit</i>	Profit by commercialisation	Network and environmental spillovers
<i>Innovator</i>	Firm	Network
<i>Risks</i>	Market failure	Free riding, opportunistic behaviors

*Source:* based on Open source software and the “private-collective” innovation model: Issues for organization science (von Hippel & von Krogh, 2003).

von Hippel and von Krogh (2006) argued many advantages from free revealing that may be summarised into three main categories:

a) build reputation: firms that are the first to give access to a new technologies may achieve a strong positive image of innovators on markets and with other partners. In network-to-network competition many firms benefit from reputation because it allows them to achieve a good position in an established network.

b) setting standards: an innovation freely revealed has major possibilities to become a dominant design in the market. Firms that are producers of such design will be advantaged in the next commercialization phase. In electronics usually an open standards is set and firms that belong to those open standards increase its chance to see its innovation widely adopted. De Fraja (1993) argued that being the first to reveal on the market may overcome the advantages achieved by first mover innovators that not reveal.

c) increase learning and development capabilities: Foray (2004) suggested that in a knowledge perspective, a strong propulsion to innovation was supplied by knowledge-sharing. A new technology freely revealed may be improved by all parties and this will promote a collective learning by doing.

In electronics many firms have an own platform who promotes and set Open Source, showing several degree of openness (Table 12).



However, firm's initiatives are not the only ways to free revealing. Many communities born in the last years as a voluntary places of contact among developers (Table 12).

**Table 12:** Open source projects by firms

<b>Firm</b>	<b>Platform</b>
<i>Samsung</i>	Samsung OSRC
<i>Apple</i>	Apple Open Source
<i>Microsoft</i>	Microsoft Openness
<i>Oracle</i>	Oracle and Open Source
<i>LG</i>	Open Source Code Distribution
<i>HP</i>	Hewlett-Packard Enterprise
<i>Intel</i>	01.org
<i>SAP</i>	Sap Community Network
<i>Google</i>	Google Developers / Open Source Programs Office
<i>Texas Instruments</i>	Opensource.ti.com

According with the out-licensing section, firms have three potential ways to exploit their technologies. In the first option, they may keep the technology inside the firm's boundaries because they have the sufficient complementary assets (e.g. marketing) to commercialise with success the new product. In this option, firm has to beat the competitors and manage the entire innovation process.

**Table 13:** SourceForge platform for open source

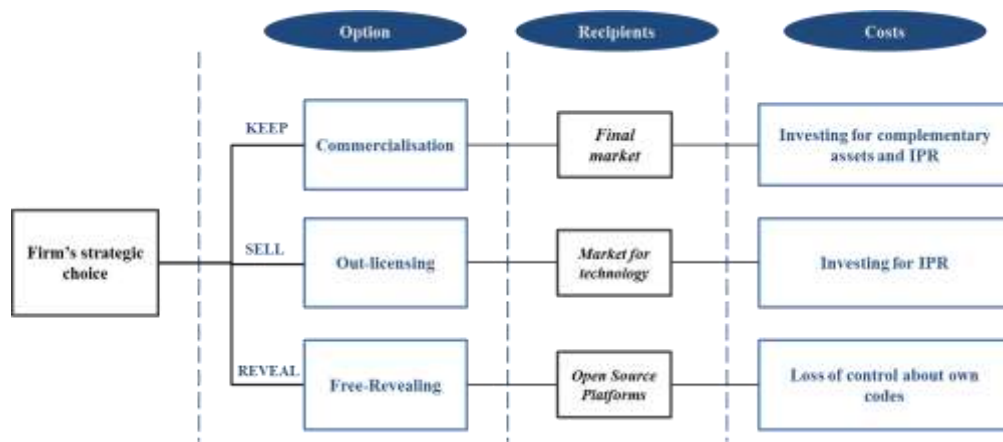
<i>Mission</i>	SourceForge is an Open Source community resource dedicated to helping open source projects be as successful as possible. We thrive on community collaboration to help us create a premiere resource for open source software development and distribution.
<i>Facts</i>	430.000 projects, 3,7 million of registered users, 41,8 million of customers, 4.800.000 downloads a day.
<i>Activities</i>	to develop, download, review, and publish open source software.

*Source:* based on Sourceforge website (2016), consulted on March 15<sup>th</sup> 2016.

In a second option, firms sell their output on the market for technology, in order to avoid competition and investments on complementary assets. If technology is not coherent with firm's business model, or it haven't resources to invest in complementary assets, this option permit to profit from innovation.

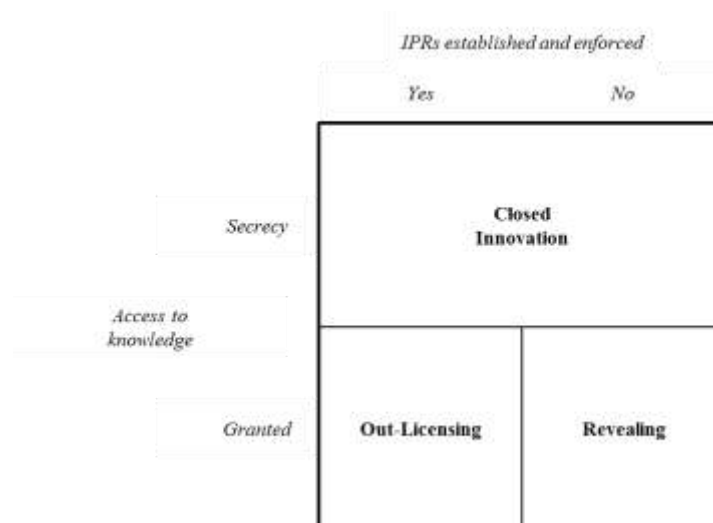
Finally, in a third option, firm may choose to reveal its technology to the public with the aforementioned advantages and caveats.

**Figure 20:** Firm's strategic choice in inside-out processes



Even if the second two options are example of inside-out processes of Open Innovation, they are quite different alternatives. In fact licensing is largely based on strong investment on Intellectual Property Rights (IPR).

**Figure 21:** Matrix of inside-out processes based on ipr



*Source:* based on The emergence of openness: How and why firms adopt selective revealing in open innovation (Henkel et al., 2014).

Technology transfer involves high risks of opportunistic behavior by potential partners, also, costs of litigation about innovation outputs are discouraging in the out-licensing strategy (Harhoff et al., 2003). Also, for those firms able to protect themselves from imitation, keeping a secret is possible only for a limited period. In some industries the time in which a patent assure the secret about a new technology is about 12-18 months (Mansfield, 1985).

In the past the choice between out-licensing and revealing was simplified by the customer preferences. Before Linux firms wasn't felt stressed about the demand for source code. Later, many customers expressed a strong favor for open source code, because the opportunity to increase their utilities. When the demand had showed a pull dynamic, firms begun to explore the dimension of free revealing and, after, observed a positive experience by its implementation (Henkel et al., 2014).

## *Chapter 3*

### **Knowledge Sourcing and Real Options**

Among the main kind of processes considered in this thesis, sourcing is that with further study from literature. Both Asian and Western schools have deepened, although with different labels, similar methods of acquiring knowledge from sources placed outside the firm's boundaries, from subjects such as: universities and research centers, competitors, costumers and other organisations.

In the US school of Open innovation (Chesbrough, 2003) the principle of the paradigm is the phase of sourcing, that is a preliminary screening aimed to monitor the external environment for the presence of ideas and technologies, available outside the company, before activating the internal R&D function (Dahlander & Gann, 2010).

This process is necessary because large firms seem to devote increasing resources to the development instead of to basic research, considered more expensive and uncertain. In this chapter will be deepened some theoretical frameworks about how and why firms are preferring an open approach to knowledge sourcing.

#### **3.1 Knowledge Sourcing: A Theoretical Overview**

Search for new external sources, also called External Technology Exploration, is fundamental to compete in emerging technologies.

There is a lack of literature about the nexus formed by Open innovation and strategy. In fact there are many precautions to consider in the literature. A great example is the concept of technology roadmap. According to Groenveld (1997) *“roadmapping is a process that contributes to the integration of business and technology and to the definition of technology strategy by displaying the interaction*

*between products and technologies over time, taking into account both short- and long-term product and technology aspects”.*

Aforementioned strategic orientation involves a sort of bond to a set of technologies in which the company decides to invest for its future development. Thus, roadmapping become an bond to the concept of continuous openness toward the external environment, and, in particular, it involves an excessive risk of concentration about know-how and competencies in few solutions, less adaptable to the market evolution.

What does happen if after a relevant investment about a set of technologies, they become antiquated when related to market needs? What does happen if an innovation, also belonging to other industries, subvert the natural market trend?

Firms that follow their roadmap may obtain only two kinds of results: a success or a failure. Instead, an open sourcing strategy, thanks to options, diversifies the risks and increases the strategic flexibility (Chesbrough, 2004).

Sourcing optimal dimension is not achievable with the maximisation of the number of sources, on the contrary, breadth and innovative performance are characterised by a curvilinear, or inverted U-shape, relationship (Laursen & Salter, 2006).

Optimal dimension is reachable instead with a right balance among costs and benefits earn by the sources (Keupp & Gassman, 2009). Increasing the breadth (number of sources), augment the costs sustained for relationships communication and control (Stuermer et al., 2009), and a efficiency reduction due to a resources repartition on too technologies. Costs and risks are depending by several criteria tied to the technology/option under sourcing, as shown in the following table (Table 14).

**Table 14:** Differences between knowledge sourcing

	<b>Raw ideas</b>	<b>Market-ready ideas</b>	<b>Market-ready products</b>
<i>Type</i>	Licensing agent, marketplace, idea scout, broker...	Innovation capitalist	Internal / external business incubator, venture capitalist
<i>Costs</i>	Low	Medium	High
<i>Risks</i>	High	Medium	Low
<i>Speed</i>	Low	Medium	High

*Source:* based on A buyer’s guide to the Innovation Bazar (Nambisan & Sawhney, 2007).

Once clarified that a sufficient number of external source can favor better innovative performances, another issue to unravel regards the intensity of source-firm relationship: the depth (Laursen & Salter, 2006).

Centrality and importance of relationships are coped by network literature. Gemnden (1992) already proved that firms with technology-oriented external relationships are more innovative than others without them. Miotti and Sachwald (2003) illustrated the correlation between a firm's innovativeness, based on the number of patents, and its number of cooperations. Koschatzky et al. (2001) found that firms which do not exchange knowledge are reducing their knowledge base on a long-term basis, and lose their ability to enter into future relations with other partners. Members with a clear strategy choose their network membership according to its relevance and the usefulness for their knowledge and innovation goals (Enkel, 2010).

Open innovation demands a connection to external sources of NPD inputs (e.g., Rampersad et al., 2010), in order to the expression Connect & Develop economy is well fitted (Dodgson et al., 2006). Such a connection in turn requires boundary-spanning activities by the firm (Wuyts et al., 2004) who might involve a firm's informal relationships and interactions with other organisations that operate in similar, or complementary, industries and technologies, or even with competitors (e.g. Luo et al., 2007).

In technology intensive industries such as biotechnology or electronics, network approach and alliances have usually been a more important instrument to guarantee knowledge or complementary resources (Powell et al., 1996; Mowery et al., 1996; Bekkers et al., 2002). In this way, inter-organisational transactions should not be structured only to economise the transaction costs but also to maximise the transaction value (Dyer & Singh, 1998). Several authors listed some source of innovation and for each one, the firm needs to develop long term or short term relationship with the aim to develop strategic value and learning opportunities (Kogut, 2000). Saint-Paul (2003) described a networking imperative which is present in many high-tech industries as: *"In an industry with, say, 10 firms similar in output and investment in R&D, each member of a nine-firm technology cartel [or network]*

*can expect to obtain immediate access to nine times the number of innovations that the remaining enterprise can anticipate on the average*". Once the concept of inter-organisational innovation has entered an industry, everyone who does not participate will cope serious competitive disadvantages (Enkel et al., 2009).

Table 15 shows that not only formal relationships exist. An R&D director said that *"knowledge flow is the lifeblood of our division, but it is invisible to us. It all happens informally"* (Whelan et al., 2011). In the past, some authors argued that relational factors can be the 'frequency' of contact (Echeverri, 1999; Hage & Hollingsworth, 2000), or the network relationships' 'durability' (Echeverri, 1999), while others underlined the network 'intensity' (Arrigo, 2011; Gemünden & Heydebreck, 1994; Koschatzky, 2000). Summarising, network literature mastered the importance of relationships in value creation.

Many innovations are the outcome of systemic and strategic plans. For this reason the most innovative companies make a note of their innovation strategies, reveal it to their employees and discuss it periodically, encouraging the team spirit and allowing them to submit their own proposals (Lundberg et al., 2013). Openness means reciprocity that not regards an altruistic, and economically irrational behavior, but a strategy that builds on well-understood self-interest (Enkel, 2010).

Gray and Meister (2004) suggested a classification among three degrees of knowledge sourcing distinguishing by information seeking that is limited to gathering facts and opinions from environment. The authors defined this following degrees:

- dyadic knowledge sourcing, based on a one-to-one relationship;
  - published knowledge sourcing, based on a one-to-many relationship;
  - group knowledge sourcing, based on communities relationship, such as: practices communities or on-line communities.
- Each kind of relationship request a different level of involvement. To manage communities is more complicated to a one-to-one relationship that replicates into the company's boundaries the knowledge owned by the source.

**Table 15:** Technological knowledge sourcing and time horizons

	<b>Short Term</b>	<b>Long Term</b>
<i>Objectives of the relationship (expectations)</i>	New or improved product or process	(a) Aligning future technological competence with future markets (b) Developing new businesses and activities
<i>Type of relationship</i>	Contractual, formal	(a) Reciprocal, Informal (b) Ownership-based
<i>Type of knowledge involved</i>	Higher codified component	Higher tacit component
<i>Characteristics of partners</i>	Dependable	Explorative, flexible
<i>Business Function</i>	Development/production	Research/Marketing
<i>Degree of uncertainty</i>	Low	High
<i>Degree of risk</i>	High/Medium	Low/Medium
<i>Technological profile</i>	Incremental	Discontinuous/disruptive
<i>Market prospects</i>	Predictable	Speculative
<i>Performance measurement</i>	Metrics	Positioning against perceived rivals
<i>Importance of IPR</i>	High	Medium/Low

*Source:* based on The sourcing of technological knowledge: distributed innovation processes and dynamic change (Howells et al., 2003).

As a result network literature converged with Open innovation because both are built on the pillars of relationships with partners, in this specific domain, aimed to transfer knowledge to the focal firm.

### 3.2 External Source as Real Options

Several studies have analysed the tie between the theory related to Real Option Theory (hereafter ROT) and innovation. Through the concept of openness there is a greater willingness to consider the two strands of research together (Nigro et al., 2014; Vanhaverbeke et al., 2008; Fredberg, 2007), considering the ROT as a backbone of at least two processes of firm's openness, such as sourcing and acquiring.

Many high-tech firms must operate under high levels of uncertainty because a lack of clear information on future changes (Lawrence & Lorsch, 1967). In recent years, real options have become more important on the global markets as a source of strategic flexibility. They may give to organisations capacities and mechanisms to



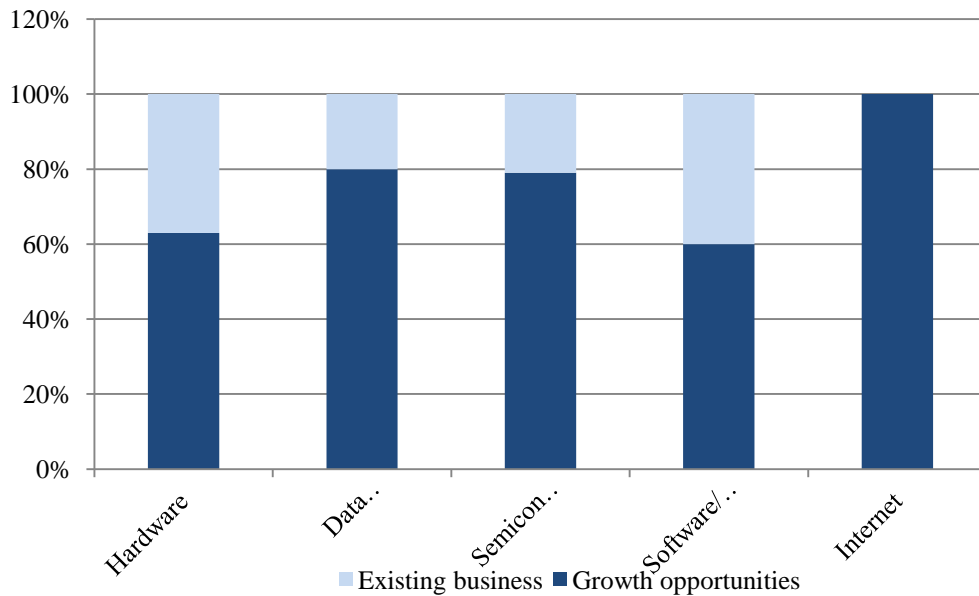
adapt, in order to implement the changes required by the external environment, on both the operative and the strategic levels (Verdu et al., 2012). Sanchez (1993) defined real options as the “*right to choose whether or not to carry out an action at the present moment or in the future*”. An option gives the right, but not the obligation, to take a specific decision (such as: invest, defer, alter) regarding an underlying asset, or to buy or sell an asset at some point in the future, for a predetermined price or before a certain time (Verdu et al., 2012).

Considering that there are several forms of uncertainty, Real options theory becomes necessary where uncertainty is at the highest level. When a new technology is in search of potential applications, the innovating firm usually has in the first stages no well-defined idea of potential target customers and how the technology can create value. Usually, how the firm may create and capture value only becomes clear after extensive market research, lead user interaction and investments in application technology. Moreover a firm may perceives a potential market opportunity but has to develop a technology to create the business (Vanhaverbeke et al., 2008). Firms today face unpredictable changes in the environment that surrounds them. They have different strategies and courses of action for confronting this uncertainty (Hitt et al., 2000). Some decades ago, Burns and Stalker (1961) tied environmental uncertainty to unpredictability. Lawrence and Lorsch (1967) described it as the unavailability of clear information about the external environment.

Starting with the assumption that innovation concerns every industry, there are some markets more affected by its conditioning. For example internet technology, a pioneer among innovative fields, is more suitable than others for uncertainty about the future.

Jagle (1999) divided company value in IT industry in two components: value from existing business and value of growth opportunities. The following figure 22 shows how much innovation in IT markets is crucial for the survival of the firms who compete in it.

**Figure 22:** Firm growth in IT markets



*Source:* based on Shareholder value, real options, and innovation in technology-intensive companies (Jagle, 1999).

Grant et al. (1995) identified two factors of superior profits in IT: differentiation and potential for establishing competitive advantages. Later, the facts sustained its argumentation with start-up such as Compaq, Oracle and Sun, that rose more than 40% a year or more (Jagle, 1999). Recently the trend is confirmed thanks to the global outbreak for convergent products (Table 16), and for the changing of competition settings as in the mobile market (Table 17).

When an industry depend on growth opportunity there is the necessity to maintain an open vision about the sources of innovation and, at the same time, firms need to valorise the advancement in technology that are not central with its own business model (Vanhaverbeke et al., 2014).

**Table 16:** Sales of electronics devices on US market in 2015

<b>Product</b>	<b>Revenue *</b>	<b>Sold units **</b>	<b>Growth</b>
Smartphone	55	183	4%
Tablet	18	60	4%
3D Printer	152	0,179	38%
Wereables	3,7	13,6	22%
Drones	0,953	2,9	115%
Smart Homes	1,2	8,9	18%
Laptop	14,7	27,7	2%
Virtual Reality	0,540	1,2	440%
Televisions (4k uhd)	10,7	13	65%
* billions of US dollars; ** millions of units			

*Source:* based on 2016 U.S. Consumer Technology Outlook, Consumer Technology Association (2016).

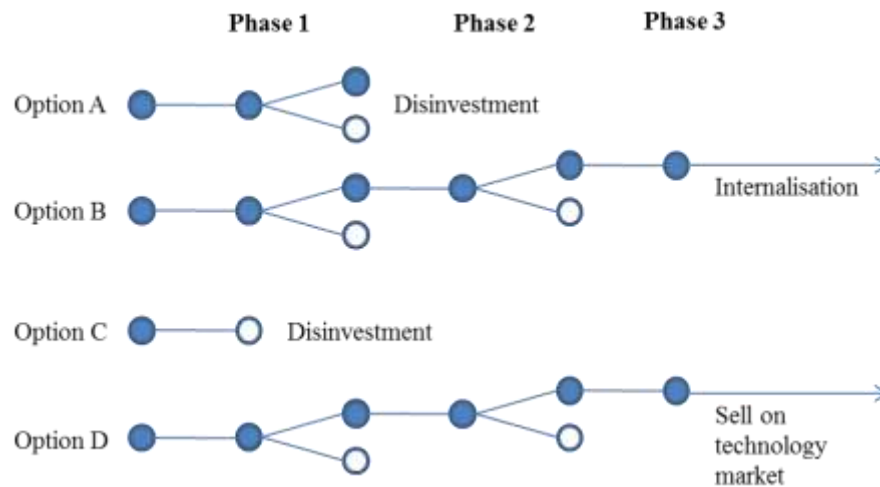
**Table 17:** Competition on largest mobile handset manufacturers

<b>#</b>	<b>2000</b>	<b>2012</b>
<b>1</b>	Nokia	Samsung
<b>2</b>	Motorola	Nokia
<b>3</b>	Ericsson	Apple
<b>4</b>	Siemens	ZTE
<b>5</b>	Panasonic	LG Electronics

*Source:* based on Gartner Dataquest (2010, 2012).

According with the literature about ROT, firm, in a first phase, called ‘option creation’, invests in the creation of several options for the launch of different basic research projects. In the following phase, called ‘option exercise’ firm chooses to invest only for the projects that are coherent with its business model (Vanhaverbeke & Cloudt, 2014). Once an option has become a valuable technology, that are not useful for company potential markets, it may be sold to external organisations in the market for technology.

**Figure 23:** Real option theory and gradual investments



The main advantage in this framework is the opportunity to invest, in a gradual way, in several technologies, increasing the firm flexibility and reducing the likelihood to remain anchored to a single path of basic research. Conversely, traditional R&D expenditures are characterised from high dependence among the initial investment and the new product development (van Haverbeke & van de Vrande, 2008). Differences between ROT and closed innovation investment are highlighted in the following table 18.

**Table 18:** Comparison of closed and open approaches to innovation

	<b>Closed Innovation</b>	<b>Real Option</b>
<i>Time</i>	Investments in few projects involve high degree of path dependence and a high time lag for develop a technology. During this time lag the technology may become obsolete.	Investments in several projects reduce the path dependence. Technology are saleable also in firsts stage of development to other organisations, early that they become obsolete.
<i>Technology Portfolio</i>	Few technologies tied to few projects but with major depth.	Many technologies tied to many projects but with less depth.
<i>Control</i>	High control on the technology portfolio.	High control on the resources dedicated.
<i>Costs structure</i>	Rigidity caused by path dependence.	Flexibility thanks to gradual investment.
<i>Results</i>	Success projects (new products) or failed projects (not saleable products).	Multiple alternatives such as: success projects, failed projects, or intermediate technology.

Once that the firm has selected an option, its execution requires a flexible, rapid and iterative learning cycle. Therefore, while emphasising common products and

practices is important for capturing efficiencies, too much emphasis on routine actions can make hard for companies to adapt or to walk away from losing situations in the future (Bingham et al., 2014). Option exercise involves internalisation of a technology and hence the management of absorptive capacity and routines. When an option is not exercised it won't be internalised. In this case the rejected technology, not coherent with company's business model, may be sold outside on the market.

ROT framework concerns the left side of the Chesbrough's funnel where the innovation process starts and uncertainty has the highest level. In the management literature, real options reasoning is often considered as a tool for uncertainty reduction, making a small, initial investment, under high levels of uncertainty that allows one to create an option, while waiting until the uncertainty about the opportunity has decreased. When the uncertainty decreased, the investing firm can decide whether to make a follow-on investment or whether to abort the project (Adner & Levinthal, 2004; McGrath & Nerkar, 2004).

**Table 19:** Comparison for Real option theory

<b>Caveats</b>
- Firms may have to trade part of their intellectual property rights in order to enlist the investment and support of other firms.
- The financial benefits of this are more interesting in the early stages of the innovation funnel, because application-specific investments in the later commercialization phase may be sunk costs, and harder to recover or redeploy.
<b>Advantages</b>
- Firms benefit from early involvement in new technologies or business opportunities. External partners help the firm to get access to a broad range of externally developed knowledge.
- Firms may benefit from delayed entry or delayed financial commitment to a particular technology. In fact, minor investments for the company enable to scout technologies in a more effective way.
- Open innovation offers firms the advantage of an early exit, and the ability to realize some value from projects that do not go forward internally.
- Firms may benefit from delaying an exit.

*Source:* Theories of the firm and open innovation (Vanhaverbeke & Cloudt, 2014); Understanding the advantages of open innovation practices in corporate venturing in terms of real options (Vanhaverbeke et al., 2008).

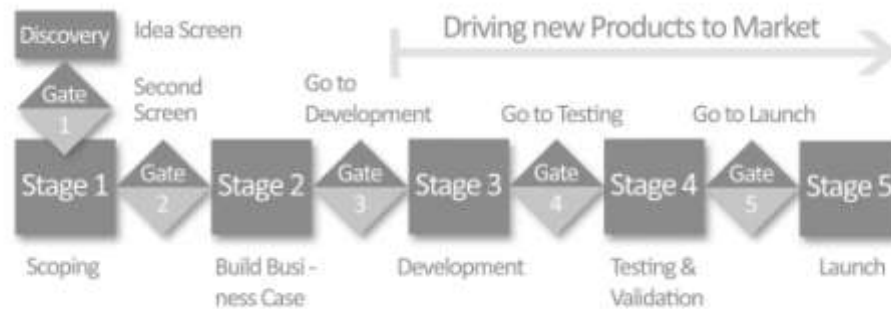
At the start of the innovation process, there are few rules to follow in choosing an opportunity, to begin with, resist to invest at the first potential option. Showing restraint may not be easy when uncertainty is high and the opportunity appears to be valid (Bingham et al., 2014). Option creation rewards the first step of the process of profiting from external innovation described by West and Bogers (2011) as ‘obtaining innovation’. The authors argued about this step that “*obtaining innovations including search, sourcing, enabling, incentivizing and contracting. Initially we separated the search for external innovations from their acquisition, but we eventually concluded that for much of the sample, it was impossible to separate these processes*” (West & Bogers, 2011).

Once created several options a sorting will be the next step. A way to follow in this sorting was suggested by stage-gate model. This framework is applied primarily in product development processes and its first occurrence was in the software development domain (Salger et al., 2009). The key element of the stage-gate model is to split a process in subsequent steps, controlled by a quality gate, placed in critical points, in order to assure that the targeted goals are reached before proceeding to the next process phase. During the quality gates, the firm determines on the basis of the current status of the process, if the project must be adapted/revised or terminated (Cooper, 2008). Moreover quality gates determine distinct checkpoints, where specifically defined requirements are reviewed in a coordinated effort between process customer and process supplier. The main goal for the quality gates is an improvement of process quality, and thereby the final product quality through the monitoring and control of the product development.

In this model the decision time about the fate of an option is during the gate phase. Stage-gate rewards the NPD of a single product, but firms that are applying Open innovation replicate the same process for all the options that they have created. Obviously the gate phase is for each option in a different moment. The original conception of Open innovation seems to underline a linear model as the funnel, but other models based on external innovations have included non-linear processes with multiple phases, such as: feedback loops, integration and reciprocal interaction (West & Bogers, 2011).

During the evolutionary path from its current knowledge base and future market position, a firm may identify new knowledge and markets, revealing a gap between the market opportunities and its current technology status (Lichtenthaler & Lichtenthaler, 2009).

**Figure 24:** Cooper’s Stage-Gate model



*Source:* Perspective: The Stage-Gate idea-to-launch process — Update, what's new, and NexGen systems (Cooper, 2008).

An exercised option needs to be coherent with company’s business model (Vanhaverbeke et al., 2014) in order to permit to management to recognise the technological compatibility with existing products, or with new products.

This decision requires a high degree of absorptive capacity. In fact during the time lag between option creation and option exercise firms need to develop processes of learning by the option itself. Moreover the larger is the portfolio of options, the stronger are the absorptive capacity skills a firm will be able to build (Vanhaverbeke et al., 2008). A firm needs to successfully reconfigure, thanks to absorptive capacity, and realign its knowledge management capabilities in order to adapt to changing environmental conditions better and sooner than its competitors (Eisenhardt & Martin, 2000). In some particular projects, internal ideas and external options may represent substitutes. In this case, a firm may decide on the ‘make-or-buy’ dilemma but, at the organisational level, the internal and external knowledge management processes are often complementary (Cassiman & Veugelers, 2006; Grant & Baden-Fuller, 2004). Also, in ‘buy’ situation the option is not internalised yet. Alignment is the key factor in this approach. It allows to shape the knowledge base coherently

with environmental context. Thus, real options seem to be a good instrument for reducing uncertainty.

### **3.3 Knowledge Sourcing Facilitators**

Sourcing is a key process to ensure continuity in innovation but, at the same time, it is crucial to understand how the company can achieve its sources. One solution is to establish specialised professionals, identified with the sole purpose of monitoring the external environment in order to grasp what sources may be suitable for such purposes.

This kind of figure could take the name of 'idea scout' (Whelan et al., 2011), which would act as an antenna, in order to identify emerging technologies that can generate value for the firm. Coherently with the ROT this figure should position itself during the option creation, at a preliminary stage, and guide the selection process that will generate a portfolio of technological possibilities.

The most appropriate skills for the idea scouts are both technical and relational, where the latter is crucial because informal relationships often have a very high weight.

A certain similarity is shown in comparison with the role of 'technological gatekeeper' (Allen, 1971; Nochur & Allen, 1992) also characterised by expertise in science and technology, strong open-mindedness, lateral thinking and cross-disciplinary approach (Wolff, 1992). Rohrbeck (2010) identifies three main activities of the technology scouting, such as:

- identification, assessment and use of formal or informal information;
- build and consult a network of experts;
- facilitate the sourcing of technologies.

Among the methods available to accomplish these tasks, firm may consider the monitoring of publications and patents (Porter & Cunningham, 2005; Daim et al., 2006) and the use of data-mining tools (Porter & Cunningham, 2005). A crucial factor is that in an embryonic phase, that corresponds to the pre-paradigm phase (Teece, 1986), several technologies are developed in parallel and with different



labels. After that idea scout accomplished its task, another professional figure as 'idea connector' (Whelan et al., 2011) become essential. Idea connector is more oriented to the characteristics and needs existing within the firm's boundaries. Idea connectors have to know every existing internal R&D project and their related researchers, chiefs and technologies. Once again is shown the importance of social relations, this time of intra-firm disposition.

This second figure can also be considered in relation to the ROT but at a later stage, as the option exercise. Based on the synergy with the idea scout, the connector could be able to join each option with a specific R&D project, and he could choose in which of them make a further investment.

The communication gap between these two figures, however, involves an inefficient management of options' portfolio. In fact, many options are exercised and then converted into useful technologies, the more the sourcing strategy is likely to generate profits.

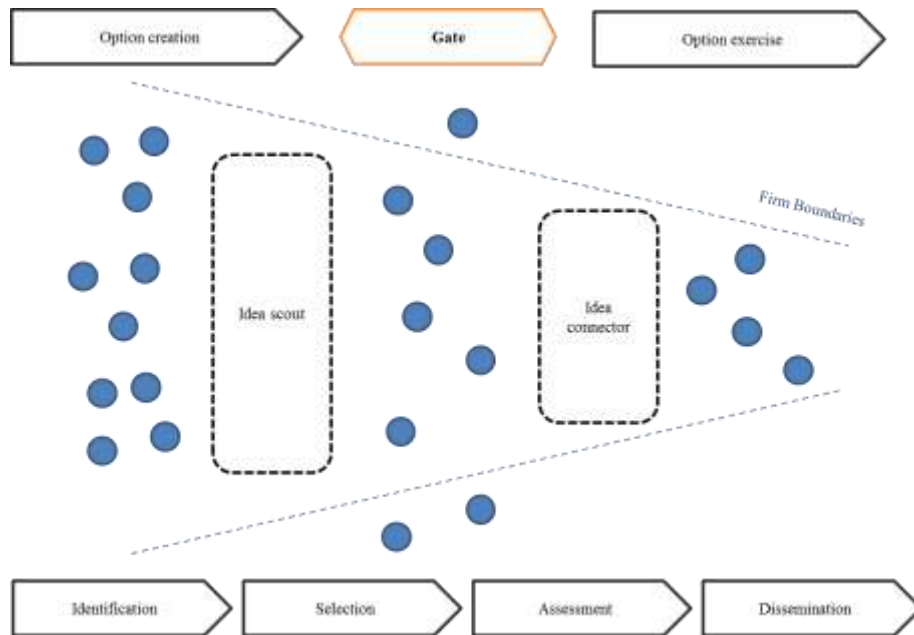
Four stages of internalisation of knowledge emerged about the technology scouting (Rohrbeck, 2010):

- identification phase: is related to the access for industry and academy information;
- selection phase: technologies are selected according to their degree of novelty;
- assessment phase: technologies are ranked on the basis of potential market size, cost savings and disruptive potential;
- dissemination phase: a "technology one-pager" will be generated for each technology with a brief description, research status, latest development and discussion of the business potential.

Applying so argued by Whelan et al. (2011) the first two phases are on idea scout's task while the fourth is exclusively in the idea connector's jurisdiction. Instead the assessment, related to the third phase, represent a convergent point for both.

This interpretation of the idea scout and connector allows to underline a stronger tie among Real option theory and Stage-Gate model, where the figure's decision may appear as several evaluation gates for the technology.

**Figure 25:** Stage-Gate and sourcing strategies



Sourcing strategic implication is consistent because goes to redefine the firm’s business model (Vanhaverbeke & Cloudt, 2014) as “*the manner by which the enterprise delivers value to customers, entices customers to pay for value, and convert those payment to profit*” (Teece, 2006).

Summarising what is discussed in the present chapter, it is important to understand how knowledge sourcing is a basic pillar in the Open innovation because by its start depend the whole innovation process. In particular it is highlighted as a Real option approach to knowledge sourcing is useful to consider a large array of external sources and ideas by the focal firm.

## *Chapter 4*

### **External Sources for Innovation**

During the twentieth century, because transaction cost analysis, innovation activities was ascribed to R&D laboratories enclosed in a vertically integrated infrastructure. At the same time, the cost of internal R&D has been drastically increased while its productivity has fallen (Paul et al., 2010).

Firms were based on their own internal R&D, obliged to use their accumulated knowledge aiming economies of scope with large scale dedicated R&D functions, useful to create barrier to entry for their competitors (Teece, 1986).

Conversely, Open innovation is founded in their roots on the basic assumption that useful knowledge is widely distributed, and that even the most capable firms must identify, connect to, and leverage external knowledge sources (Chesbrough, 2006).

Depending on the type of knowledge, sources can be categorised as (Chen et al., 2015):

- scientific knowledge: based on industry-university relationship (Perkmann & Walsh, 2007);
- technological knowledge: based on network establishment (Dittrich & Duysters, 2007);
- market knowledge (Salvador et al., 2009);
- intermediate knowledge: based on the potential positive contribution by innomediation (Shawney et al., 2002).

Indeed, the modalities for which a firm can goes beyond its boundaries for reach different sources have several categorisation as (Arora & Gambardella, 1990; Cockburn & Henderson, 1998; Granstrand et al., 1992):

- in-licensing;
- R&D outsourcing;
- company acquisitions;
- hiring of qualified researchers.

Above mentioned categorisations have not inevitably the Open innovation label but show a certain affinity with the paradigm.

Both anecdotal evidence and empirical research suggest that acquisition from external sources not involve a substitution effect of internal commitment as argued from transaction cost theory (Williamson, 1985; Pisano, 1990).

According to industrial organisation approach, more technology spillover there are and greater are the incentives to cooperate with other players (Petit & Tolwinski, 1999). Indeed in strategic management approach cooperative behavior is a way of accessing additional resources with the aim to reach a competitive advantages (Teece, 1986).

However, it is important underline that openness not excludes internal R&D investment, but also internal and external processes need to be complementary (i.e. the increase in intensity of one encourage the marginal return of the other) because from an absorptive capacity perspective, internal R&D also enhance company ability to identify and use external knowledge (Dahlander & Gann, 2010). As a results the following chapters show how several external sources can improve the firm's innovation output.

#### **4.1 Public Policies and University-Industry Relationships**

Increasing in technology complexity have brought economy to reconsider ties among private companies and public institutions that pursues research. University knowledge has increased thanks to patents, joint-venture and spin-off. The generic economic and social benefits from public research have long been recognised as an important source of industrial innovation, especially in some industries (Cohen et al., 2002; Mansfield, 1991; Pavitt, 1991; Salter & Martin, 2001).

In general, public policies considerably affects on innovation costs and performance, and in the following paragraph will be included some facts that have conditioned the global markets trend.

There are three important reasons who underline the reconfiguration of university role in innovation. First, the promotion of structure that encourage relationships between university and business such as science parks and property-based

institutions (Siegel et al., 2003). Second, the normative stimulus for development of laws on intellectual property (Segarra-Blasco & Arauzo-Carod, 2008) and public education, wanted both for economic reasons and social issues. Finally, in many countries budget, early dedicated to funding public research, was so downsized to cause a strong academic interest for do research activities useful for local firms (Mowery & Sampat, 2001). Various trends confirmed these statements such as:

- diffusion of technology transfer offices (Siegel et al., 2003);
- increasing in public-private PhD careers – PhD sponsorship;
- a growing share of industry funding in university budget (Hall, 2004);
- growing universities revenue from licensing generated by an increasing patent propensity (Mowery et al., 2001);

Although funding is a critical issue for university-industry interaction, National Science Board (1996, 2000) highlighted three further causes of universities interest to engage with industries:

- to expose their students and faculty to practical issues;
- to create employment opportunities for their graduates;
- to gain access to applied technologies.

However, the institutional assets of the academic world may be a bond. In fact, a restrain factor to partnership for the scholars is the motivation for collaborate with private because it is less valuable in term of career advancement, especially compared with publications and other theoretical research outputs (Tartari et al., 2014).

From a normative perspective, each country keep autonomy in intellectual property management and relative laws. Only about IP safeguard there is a strong disagreement among several national policies about deposited knowledge.

The resources provided by national, or supranational policies into the economy, influence the firms behavior on several degrees. R&D investments by public organisation analysis has shown the individuation of some country-leader for innovation support. The following table shows the Gross Domestic Spending invested by public institution that hosted some of the most innovative firms on the global markets.

**Table 20:** Gross domestic spending leaders on R&D by country

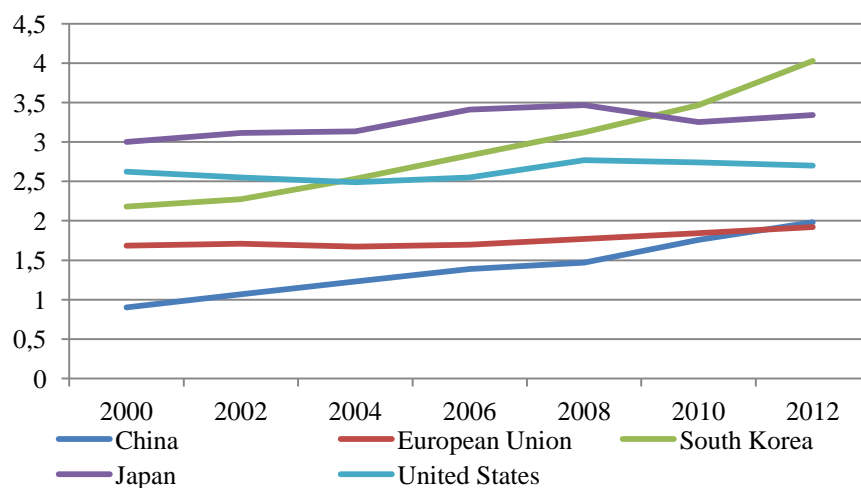
Country	Gross domestic spending on R&D (total % of GDP)						
	2000	2002	2004	2006	2008	2010	2012
China	0,903	1,07	1,23	1,388	1,47	1,759	1,982
European Union	1,684	1,708	1,671	1,697	1,77	1,842	1,919
South Korea	2,18	2,274	2,532	2,831	3,123	3,466	4,026
Japan	3,002	3,116	3,133	3,409	3,467	3,254	3,343
United States	2,624	2,55	2,49	2,55	2,767	2,74	2,698

Source: based on OECD data (2015), consulted on December 12th 2015.

From this comparison emerges that during the beginning 21th century the first investing country was Japan, with a three-times superior intensity to China, and, South Korea, the first investing country in 2012, have almost doubled its efforts.

Following figure highlights the country trends and shows that the Western economies have an increase significantly weaker than Asiatic economies. These data are coherent with the results achieved by firms hosted by the aforementioned countries, placed at the highest positions in hi-tech markets such as Samsung, LG and Lenovo.

**Figure 26:** Evolution of gross domestic spending on R&D by country



Source: based on OECD data, consulted on December 12th 2015.

Patents usually are considered an innovation index, or at least a proxy. However the tendency to patent an invention may be strong influenced by public policies.

Previous tables and figures show an incongruity among the most R&D investing countries and those who have the major propulsion to patent.

**Table 21:** Trend about patents by country

Number of Triadic Patent Families						
Country	2008	2009	2010	2011	2012	2013
<i>China</i>	824	1.295	1.417	1.542	1.657	1.785
<i>European Union</i>	14.737	14.460	13.558	14.067	14.111	14.161
<i>Korea</i>	1.827	2.108	2.460	2.668	2.887	3.154
<i>Japan</i>	15.723	15.326	16.042	16.423	16.220	15.970
<i>United States</i>	13.852	13.553	12.823	13.254	13.819	14.606

*Source:* based on OECD (2015). Main Science and Technology Indicators.

Table is based on Triadic Patent Family, that is series of patent placed by the same inventor, for a specific invention, simultaneously on European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO).

Even though China and South Korea are pro-active in R&D, there is a relative scarce propulsion to patent, whereas in Western economies and in Japan it is very high.

There are three relevant law reforms that positively influenced the role of the public research as a source of innovation, such as:

- the Bayh-Dole Act for US research;
- the role of financier carry out by South Korea government;
- the Japanese Technology Basic Law.

US Bayh-Dole Act (1980) had a preponderant role about the purpose of government stimulus to public research, because the possibility to transfer the exclusively control of many inventions, produced by university and private organisation projects that operate with federal agreement with the aim of commercialisation. Bayh Dole Act was so important in the US system that caused a rapid increase of the number of patents deposited by universities and colleges.

**Table 22:** Trend of US patents in the second half of twentieth century.

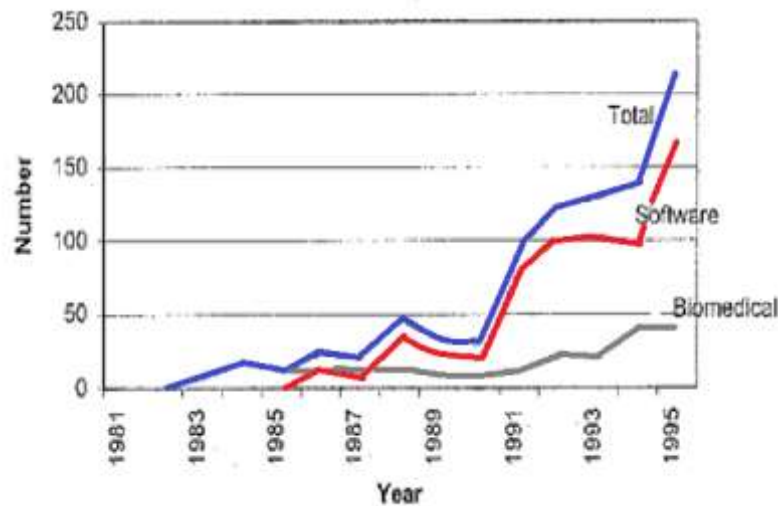
Timing related to Bayh-Dole Act	Number of Patents
One year before	264
After four years	551
After nine years	1228
After fourteen years	1780

Source: United States Patent and Trademark Office (1998).

Patents were not the only indicator of the augment in research activities made by US universities. Also, in 1980 there were only 25 academic institutes equipped of transfer offices, whereas in 1990, they increased to 200, with a growth rate of 87,5%. Revenues from licensing tripled from 1991 to 1997, with an increase of 476 million of US dollar (Mowery et al., 2001).

Software and biomedical innovation, still hi-tech pioneer, were preponderant pushing the whole economy, as shown in figure 7.

**Figure 27:** Columbia University license agreements



Source: University patents and patent policy debates in the USA (Mowery et al., 2001).

Beside to the Bayh-Dole Act there was the choice by US governments to encourage the education, thanks to collaborative researches, high-technology clusters such as Silicon Valley (Saxenian, 1994; Brondoni, 2008) or the biotechnology cluster linked to Massachusetts' universities (Owen-Smith & Powell, 2004). Moreover US system



is based on a model strictly tied with the safeguard of IP about several essential patents, useful to defines standards (Brondoni, 2013).

Japan is another country that may praise several best players on the electronics market, and also it implemented a series of pro-research policies. In particular with the approval of the Science and Technology Basic Law (1995) was regulated a big portion of the national innovation system. In 1999, Japan provided support to the university thanks to a normative comparable with the US Bayh-Dole Act, but with a more radical implication because a transformation of the universities into independent organisations (Woolgar, 2007).

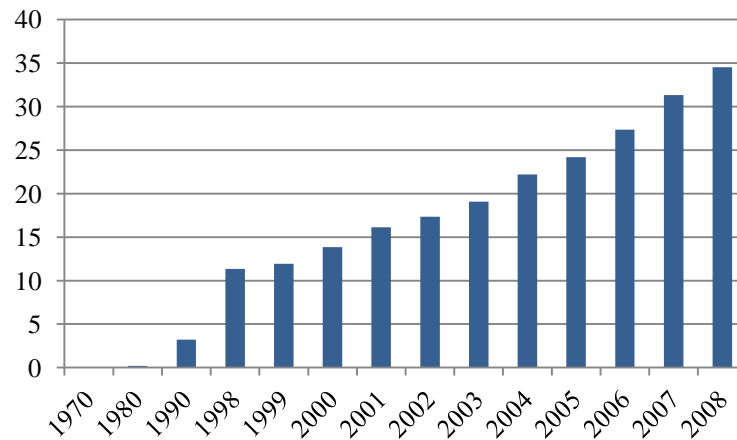
A so advanced normative apparatus explains the strong tendency of the Japanese firms to deposit patents, and provides a strong support to the explosion of the number of collaboration appeared from the 1990 to now (Kato & Odagiri, 2012). Instead, Japanese *keiretsu* are less inure to embed organisations with different background, for avoiding ‘culture clash’ (Furlan, 2002; Veiga et al., 2000).

South Korea is an example in which support to R&D overlook the involvement of a unique normative and are linked to an entire country-system obligation, strictly oriented to technology development. South Korea’s history has produced a sort of path dependence that brought several national corporations to the top in their industries.

After the World War II the government has always sustained a strong integration of the economic policies, targeting the technology which main driver of growth.

At the basis of the integration, preceded by the establishment of the Ministry of Science and technology (1967), National Council for Science and Technology (1973) and Government Research Institute, there was a strong investment in the human resources development (Kim & Dahlman, 1992), proved by records in several educational index (Westphal et al., 1985). Also, private sector was conditioned by public policies that are oriented to reward those *chaebols* characterised by good performance. In fact, *chaebols* registered an unexpected growth: from 1974 to 1984, the GDP quote produced by the first ten corporation increased from 15,1% to 67,4% of the total, thanks to the prevailing influence of the larger *chaebols* such as: Samsung, Hyundai, Daewoo, Lucky Goldstar (LG).

**Figure 28:** R&D expenditure in South Korea



*Source:* based on MEST, Korean Ministry of Education, Science and Technology (2010).

In U-I relationships, South Korea has historically been less active because a lag among academic realm, oriented to a high quality education, and the industrial realm, prevailing oriented to develop engineering (Kim, 1997).

During the 21th century this cycle was interrupted because the fulfillment of the *Law on industrial education and industry-university cooperation* that created a breach for the diffusion of technology transfer centers (Hemmert et al., 2014).

In firm's perspective, science-based universities allow to facilitate knowledge flows and to contribute for better innovation performance, with a clearer understanding of knowledge base under the new technology development (Chen et al., 2015).

The dynamics of the relationship among universities and firms involves a high number of transactions. Disposition and cost of those relationships heavy depend on the bureaucratic structure of the academy, that may produce an incentive or a bond for technology transfer (Bercovitz & Feldmann, 2006).

A positive example of academic policy in favor of technology transfer may be the expression, 'entrepreneurial universities', proposed by Etzkowitz (1983) as a description for those universities proactively committed to research promotion.

Perkmann and Walsh (2007) discerned three degree on relational involvement in university-industry links.

A low involvement means the merely acquisition of university's patents by companies or the use of scientific publications and conferences for enrich their own knowledge basis. Industrial partners may provide financial and equipment contribution as a general gift or to specific research projects. Low involvement appears the less interactive relationship. Instead, a medium involvement means mobility of people between academic and private realms. Human resource transfer represents a great example of it with the establishment of double-way multi-context learning mechanisms (i.e. training of industrial employees in university and vice versa). Finally, a high involvement entails collaborative projects. According to a porous membrane among organisations, collaboration is embedded in communities of learning that overtake the single behavior, and in this sense, it is not a make or buy decision made on the cost-benefit balancing (Powell et al., 1996).

Collaboration forms may be a research partnership or a research service when industry commits contract research and consulting, Perkmann and Walsh (2007) defined them as:

- Research partnership: *“formal collaborative arrangements among organizations with the objective to co-operate on research and development activities.”*
- Research service: *“contract research and academic consulting are paid-for services performed by university for external clients.”*

**Table 23:** University-industry links

<b>Degree of involvement</b>		
<i>Low involvement</i>	<i>Medium involvement</i>	<i>High involvement</i>
Transfer of university-generated intellectual property, formation of social relationships at conferences,...	Academic entrepreneurship, human resource transfer,...	Several forms of research partnership or commission in research services and consultancy,...

*Source:* based on University-industry relationships and open innovation: towards a research agenda (Perkmann & Walsh, 2007).

Relationships' nature and structure largely depend on the industry's features and firm's dimension.

Small enterprises are focused on survival and defense of their embryonic status with interactions aimed to strengthen their core technology in short run relationships. Indeed large enterprises are usually endowed with more resources and have the interest to diversify into not-core areas thanks to long-run relationships (Santoro & Chakrabarti, 2002).

Bercovitz and Feldmann (2006) listed others examples of informal and formal transactional mechanisms of university-technology transfer defined as:

- Sponsored research: funding universities for conducting a specific research project;
- Licenses: legal right to use a specific intellectual property;
- Hiring of students: recruitment of students;
- Spin-off firms: a new entity that is formed around a specific research.

Relationships among firms and universities, in depth terms, are characterised by two dimensions empirically studied (Thursby et al. 2001):

- universities prefer to cede, via licensing, 'proof of concept', as technologies that are distant from a final product;
- universities prefer to cede technologies via licensing, but in general terms they choose agreements that entail the inventor involvement for the future project development.

These two dimensions are linked to the disposition itself of the academic realm, that is strictly correlated to basic research and it is far from customer's needs. Conversely, firms goals are aimed to the customers, that are the reason why the company exists.

About a half of the ceded innovation has not a supporting prototype and only the 12,3% of these are ready for the commercialisation (e.g. software). The mere sourcing by universities, and the successive acquiring, are not sufficient to produce the entire new product development, then it is necessary to continue the innovation process inside the firm's boundary (inbounding).

A bond to university-industry relationships is formed by a lack of marketing assets into the academic realm. Research institutes usually achieve relevant potential results

but haven't the indispensable channels useful to communicate the innovation to the external partners, highlighting a distribution gap. An important role that break this trend is the faculty's personal communication, that take advantage by its own contacts (Jansen & Dillon, 2000). Lack of marketing competencies as complementary assets suggests a difficult appropriability of the innovation's return (Teece, 1986).

Agreements with intermediaries, also called 'innomediaries', find here a great interest, thanks to tasks carried out by professionals specialised in brokering among technologies demand and supply.

Intermediation may be useful also for overcome the 'cultural divide' between different organisations. For example, universities and research centers typically aim to maximise scientific performance, and not have a market perception (Partha & David, 1994), showing a different approach in comparison with many modern organisation characterised by a Market-driven management orientation (Brondoni, 2008). Appropriability issue is for companies strictly correlated to innovation's financial return (Hemmert et al., 2014).

Orientation diversity is directly perceptible by the organisation's missions, that usually are not clearly expressed by universities and, also may be led back to the contribution of local economic environment (Etzkowitz, 2002).

**Table 24:** Example of cultural divide

<b>Massachussets Institute of Technology</b>	<b>Samsung Electronics Ltd.</b>
<i>"To advance knowledge and educate students in science, technology, and other areas of scholarship that will best serve the nation and the world in the 21st century."</i>	<i>"To devote our talent and technology to creating superior products and services that contribute to a better global society."</i>

Source: based on Corporate Profile. Values & Philosophy (Samsung, 2013) and MIT mission (2015).

U-I relationships performance may be negative affected from the different environment, way to operate and intangible assets, bringing to under expectation results (Burnside & Witkin, 2008; Bruneel et al., 2010).

Instead, the ‘trust’ component may have a positive effect on the relationships establishment, with a strong emphasis placed by company culture. US and Japan are considered high trust countries, therefore inured to a more actively interaction with the academic realm. South Korea is considered a low trust country, because the presence of high barriers to U-I relationships establishment.

According with alliance literature, when an organisation takes the choice to collaborate with others, some informal factors are crucial for the partner evaluation (e.g. organisation’s history, solid reputation provided by word-of-mouth).

Closing the typologies of sources provided by public research centers there is the spin-off case. According to Shane (2004) the following reasons are at the basis to the spin-off establishment:

- convert the theoretic knowledge into concrete technologies;
- wish of independence;
- high citation rates achieved by faculty linked with firms (Zucker et al., 1998).

On other hand, companies are interested in reach high skilled human resources, that are usually tied with universities (Powers & McDougall, 2005).

This logic is coherent with the needs to find unique resources, and rare imitable by competitor, resources for obtain a competitive advantages.

## **4.2 Customer empowerment and User innovation**

This chapter includes several forms of organisations that are possible source for innovation, however individuals as customers or users have an important role in modern innovative process. After the ICT evolution happened in the last decades, customers may exercise a strong influence in the address and develop of technologies and new products (Baldwin et al., 2006).

Aforementioned stakeholders are:

- firms placed on downstream of the supply chain;
- individuals as customer, users or community members.

The first one has a certain historicity, caused by the fact that those firms buying and inserting a product into own processes, are always stimulated to enhance it,

aiming to achieve a superior efficiency. For example, the most important innovations in oil refinery were developed by user firms, players of the oil-refining (Enos, 1962). The increasing production modularisation saw in several industries, in which electronics emerged, involves an enlargement of the design space and of the possible interfaces able to generate a growing number of development options (Baldwin & Clark 2006; Arora et al., 2001).

Products suffered, for a combination of divergence and modularisation, a huge vertical fragmentation, able to foster several sub-markets in which client-firms are good to innovate, making the bought product more respondent to own needs (Baldwin et al., 2006).

The second typology of customers is strictly linked to innovation and marketing management. Brondoni (2015) argued *“In a customer-centric firm the scope of market analysis shifts from an aggregate view to an individual view of customer activities. As a consequence, market research shifts its attention in acquiring the customer input that will drive improvements by customer-metrics focused on new product features: research for customers empowerment”*.

**Table 25:** Examples of User Innovation

<b>Product</b>	<b>Developing innovation for own use</b>
CAD software	24,3%
Pipe Hanger Hardware	36%
Library Information system	26%
Apache OS server software security features	19.1%

*Source:* based on Horizontal innovation networks (von Hippel, 2007).

User innovation is becoming a so relevant dimension that may be compared with the traditional production system of innovation. Hienerth et al. (2014), argued the following differences:

- a) Producers are incentivised to innovate for selling to users, whereas users innovate primarily to satisfy their own needs. The perspective is transformed from a to-user toward a by-user.

b) Producers use few employees with high specialised skills with access to R&D tools and facilities, whereas users are a large multitude of people with high variable skills.

Producers and users are very different in their role in the innovation process. Firm's employees have high specific competencies but, surely, a lower variety of approaches of problem solving if related to the creativity making available by thousands of non-professionals who have the advantage of a efficiency of scope (Jeppesen & Lakhani, 2010).

Employees have a greater depth but, unfortunately, a lack of breadth for the ways to solve a problem, especially where there is a change at the basic condition.

Moreover access to information by users is simpler because the voluntary disclosure of customer's know-how. In fact, in the past, to submit a problem to a broad number of individuals required huge costs, also monetary, on both sides; today modern communication technologies permit a noteworthy reduction of costs per contact and, allow the employ of digital platform specialised for the customer engagement, that is sometimes called crowdsourcing.

Crowdsourcing represents a new business model, accepted in the marketplace, which utilises human intelligence for problem solving. This paradigm is based on the concept that large groups of people are better to provide a solution than an elite few (Surowiecki, 2005). Howe (2006) is the first person that described this paradigm as follow: *“crowdsourcing represents the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. This can take the form of peer-production (when the job is performed collaboratively), but is also often undertaken by sole individuals. The crucial prerequisite is the use of the open call format and the large network of potential laborers”*.

This emerging paradigm became more attractive in business and marketing because it permits to provide cost-effective results (Chanal & Caron-Fasan, 2008).

In term of rewards for the commitment in crowdsourcing activities, solvers may be called to action with two kinds of incentives: financial or non-financial.

Financial reward may be achieved on popular platforms as Innocentive. Usually these solutions are useful when the project request a complex technical efforts (e.g.



engineering projects), nevertheless it sometimes is also referred to micro-payments (Hosseini et al., 2015). Non-financial incentives depend on the solver's motivations. Solvers may take part in crowdsourcing in order to obtain recognition from their peers or social recognition for their commitment (Kazai, 2011).

Another feature that characterises crowdsourcing is the relationship among solvers and crowdsourcer. First of all, solvers are not an ongoing group of people, rather a precarious sociological environment. In online groups there are low barriers of entry and exit, then turnover phenomenon is sure. People in the groups of solver is changing and this involves several effects on the people who remain (Dabbish et al., 2012) and for example the observation of others acting is a particular hint for people determining what they want to do (Cialdini, 1998). Once understood this aspect, crowdsourcers need to develop a communication channel for feedbacks. In this environment, receiving feedback on the one's performance helps to develop a sense of competence in the job (Deci et al., 1999) and may increase pride and enthusiasm in the single contribution leading individuals to become more energetic and persistent when they faces complications. As in accountability issues such as GRI and AA1000, in crowdsourcing may be useful adopting standards for increase transparency and accuracy of the feedback. Martinez (2015) argued that when solvers receive feedback there is a threefold engagement advantage:

- physical engagement: solvers work with greater intensity;
- emotional engagement: they perceived competence is likely to increase;
- cognitive engagement: they are more willing to take risk.

Thanks to physical, emotional and cognitive engagement, feedback should promote creativity (Baer & Oldham, 2006) then crowdsourcers must be pro-active to communicate with their human capital suppliers.

Beyond the crowdsourcing peculiarities, in the user innovation, several kind of actors participate.

*a) Solvers*

There are several kind of individuals that choose to play as a know-how supplier:

- Users: who contributes to the innovation because wants to use the resulting product (i.e. users that suggests some string of code for implement software functionalities in which they are interested).

- Programmers: who have professional skills and use them for contributes to a product enhancement only for reputational advantages or for their own entertainment (Lerner & Tirole, 2002).

- Manufacturers of complementary products: who is interested to enhance components useful to tie their own product with what is object of innovation (i.e. an improvement for a software that permits the use on a proprietary hardware) (Harhoff et al., 2003).

Solvers may participate as individuals or as peer member in a community, where it is defined as a “... *networks of interpersonal ties that provide sociability, support, information, a sense of belonging, and social identity.*” (Wellman et al., 2002).

*b) Platform:*

the intermediary, digital, place where the problem may be presented. Platforms are simple site where companies display the problem, or the project, to the solvers attention. Several examples are already well-known for user innovation, such as Innocentive and Ninesigma.

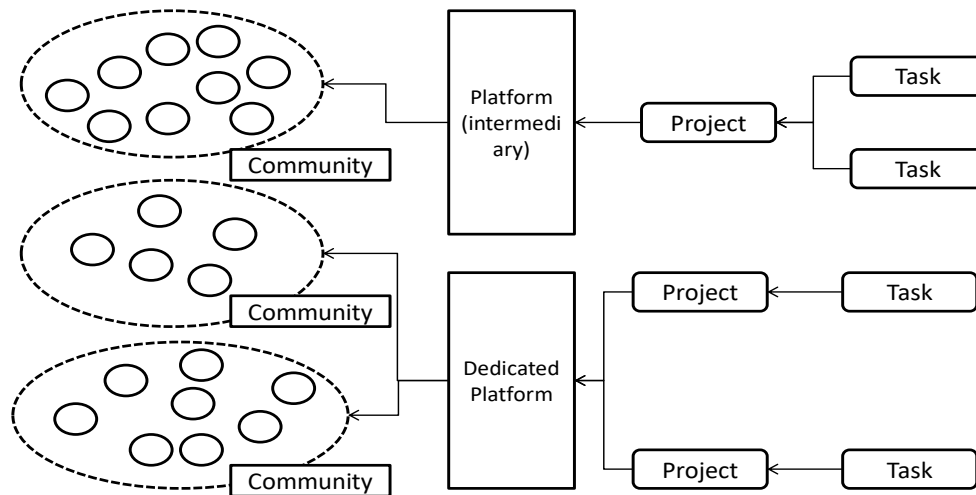
**Table 26:** Innocentive: data and facts

<b>Objectives and Results</b>
<b>Total Registered Solvers:</b> 365.000+, from nearly 200 countries.
<b>Total Solver Reach:</b> 13+ million through our strategic partners.
<b>Total Projects Posted:</b> 2.000+ external projects.
<b>Project Rooms Opened to Date:</b> 500.000+.
<b>Total Solution Submissions:</b> 40.000+.
<b>Financial Rewards</b>
<b>Total Awards Given:</b> 1.500+.
<b>Total Awards Dollars Posted:</b> \$ 40+ million.
<b>Range of Awards:</b> \$ 5.000 to \$ 1+ million based on the complexity of the problem and nature of the project.
<b>Premium Challenge Success Rate:</b> 85%.

*Source:* based on Innocentive, Facts and Stats, consulted on January 13th 2016.

Some organisations prefer to set own platform (e.g. IBM) sustaining costs for the creation of the website, and managing with their own employees the entire process.

**Figure 29:** Framework for innovation by communities



There are several condition that influence the likelihood to obtain innovation from the users (von Hippel, 2007):

- users have sufficient incentive to innovate: the only financial benefit for users from their innovation is its own internal use, or in the case of crowdsourcing a reward. Moreover for individual it is hard to manage the appropriability issue. Internal use may be a sufficient stimulus when there is an improvement of the product performance that simplifies the user work. Also, learning, enjoying and fun represents strong benefit from the users perspective (Raasch & von Hippel, 2013);
- producers have sufficient incentive to innovate: lead users is a small niche of market. Firms may don't consider them as a sufficient profitable target but also a proxy variable that identifies the clear dimension of market. This lack of clarity can reduce manufacturers' incentives to innovate. Despite these conditions, some firms as IBM profits by selling a proprietary software or hardware that complements innovation by users;
- innovators freely reveal: users are not obliged to spread their innovation. However several empirical studies show (Lim, 2000; Allen, 1983; Morrison et al., 2000) that users often prefer to given up all potential IP rights to other peers or to companies.

If these three conditions are respected then user innovation may be started. Antorini et al. (2012) suggested some core principles for successful interaction with users inspired by the Lego Group example of collaboration with user communities. Firm

has to know the characteristics of their users, that have a job, hobbies and family. They aren't the firm's employees and then a solid communication about modes of operation, expectations and guarantees must be done to ensure a collaborative approach. User communities aren't a company's extension but an independent entity that has own rules and peculiarity. Each community has a peculiar environment that may produce a different innovation. ICT technology allowed several types of engagement with users, also with high skills.

**Table 27:** User engagement in electronics by Lego

<b>Initiative</b>	<b>Support</b>	<b>Company's Objectives</b>
<i>Lego Ideas</i>	Digital platform	Discover new design ideas.
<i>Lego Digital Designer</i>	Software	Allow users to design and build virtual models and instructions.
<i>Lego Cuusoo</i>	Digital platform	Upload designs.
<i>Ambassador Program</i>	Digital platform	Create communities; Exploring new markets.
<i>LDraw</i>	Software	Allow users to develop and test designs based on Lego block (also with CAD support).

*Source:* based on Lego group (2015) programs and visit, consulted on 13<sup>th</sup> march 2015, available at: <https://www.secure.lego.com/en-us/aboutus/lego-group/programs-and-visits>.

Success in Lego communities with electronic features became so valid that for those users that submit, in online platform, a project with 10.000 supporters, is recognized 1% of the total net sales of the product.

Communities are useful to identify potential new markets thanks to the lead-users roles. Those people are “*users of a given product or service type that combine two characteristics: (i) lead users expect attractive innovation-related benefits from a solution to their needs and so are motivated to innovate, and (ii) lead users experience needs that will become general in a marketplace, but experience them months or years earlier than the majority of the target market*” (von Hippel, 1986).

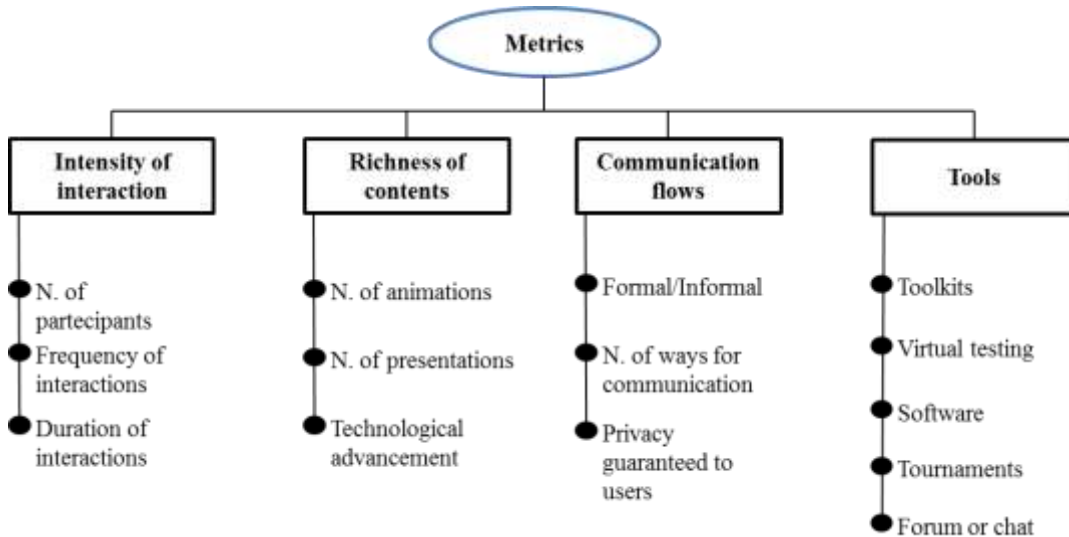
New market identification is easier when firms have relationships with lead users, that are pilot customer for the product.

Understanding the community disposition is at the basis of the innovation processes and consist in the identification of the group dynamics and the profile of

each single member, with the aim to achieve the right balance among user capabilities and the coherent task (Fuller et al., 2006).

Figure 30 shows several quantitative metrics that permit to assess the community validity.

**Figure 30:** Set of metrics for community evaluation



Source: based on Community based innovation: How to integrate members of virtual communities into new product development (Fuller et al., 2006).

In the past the role of virtual communities in marketing communication is well deepened (Gnecchi & Corniani, 2008). In relation to open systems of innovation they may actively contribute to innovation supplying a new idea, product or service. Fichter (2009) proposed a definition of Innovation communities as a “*network of like-minded individuals, acting as universal or specialized promoters [...] that team up in a project related fashion, and commonly promote a specific innovation, either on one or across different levels of an innovation system*”.

Inside a community there is a social construction where is useful a roles definition based on the competencies owned by the members (Muzzi & Albertini, 2015). Ritter and Gemunden (2003) divided these in specialist skills (technical competencies in a specific knowledge domain) and social skills (relational competencies in group management). Muzzi and Albertini (2015) used these classification, in comparison with Fichter considerations and proposed a matrix who shown three several roles in community management.

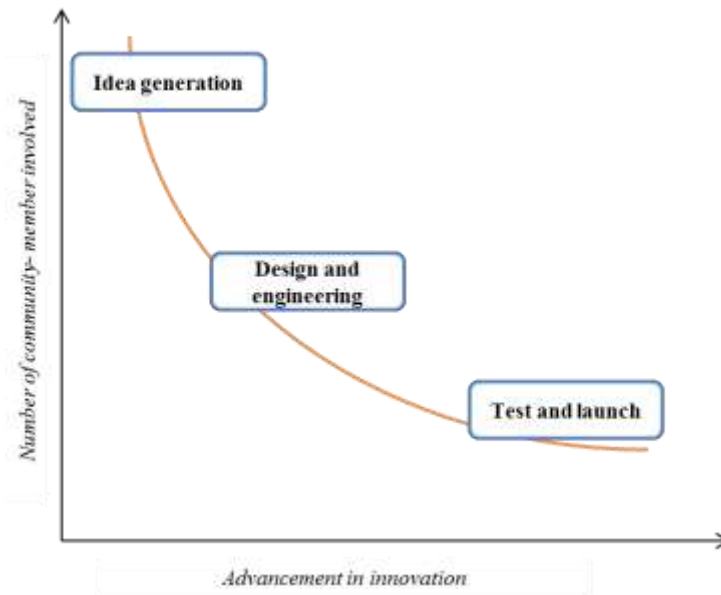
Community's members may act on different levels of engagement in innovation process. In a first phase there is a high number of members who bring their own contribution with new ideas and concepts about the product. In general, this context request a more restrained level of competencies, because creativity is crucial rather than professional skills. Members heterogeneity represents a major likelihood to achieve a greater diversity in proposals and it allows to consider different potentials of market.

It isn't the development of a lead-user group, rather than a consistent co-creation with company. At these setting community members are able to (Fuller et al., 2006):

- suggest new ideas;
- evaluate existing ideas;
- produce concept of products;
- discuss about solutions to product's issues;
- vote the product prototypes considered as the best solutions.

Costs, for community member, is paltry, exclusively linked to the time spent on the project. At a later time, a members subset acts as co-creator in design and engineering of those ideas in which company decided to exercise, coherently with what is the basic assumption of Real option theory. In this second stage emerges the importance of specialised and technological skills. Usually, who takes part in the second stage, take advantage for the knowledge acquired in own job and education. In the Lego Mindstorms programmable robotics kit development (2004), the community member John Barnes, bought his own job experience in the production of high tech sensors. As a result of his engagement there was the production of a new range of products achieved thanks to the partnership with the John Barnes's company (Antorini et al., 2012). The last stage is a test and launch phase that is usually carry out by a very lowered community subset. At this time, a lead-user group is established and firm has a clearer suggestion about new potential markets.

**Figure 31:** Path of innovation for communities



*Source:* based on Community based innovation: How to integrate members of virtual communities into new product development (Fuller et al., 2006).

A key role emerges inside the firm-community relationship: the Chief Customer Officer (CCO). This new figure has several label but is always related to a

*“top executives with the mandate and power to design, orchestrate, and improve customer experience across the ever-more-complex range of customer interactions”* (Hagen, 2011).

CCO has the sufficient power to condition the firm’s choice about resources allocation and strategic priorities, because it may bring the customer experience to top management attention.

If we consider that an open innovation culture put its basis on top management orientation, and that user innovation largely depends by customer engagement, is clear that the chief customer officer is a right candidate to become a potential instrument of enforcement about firm-customers/users relationship.

A report published by IBM, stresses the concept that traditional Chief Marketing Officer has to empower its role, and in particular *“marketers can now use data to shape everything from how brands interact with customers to the products and services they offer to the structure and culture of the company itself. By radically*

*rethinking their profession, marketers today are able to understand customers as individuals” (Gartner report, 2012).*

Innovation become possible only if company is able to establish and guarantee the community functioning, spreading its own objectives with a strong support supplied by its employees.

In user innovation, firm is interested to new product development rather than in basic reasearch that is crucial in university-industry relationships. Moreover, users, and customers, not always have a specialised education.

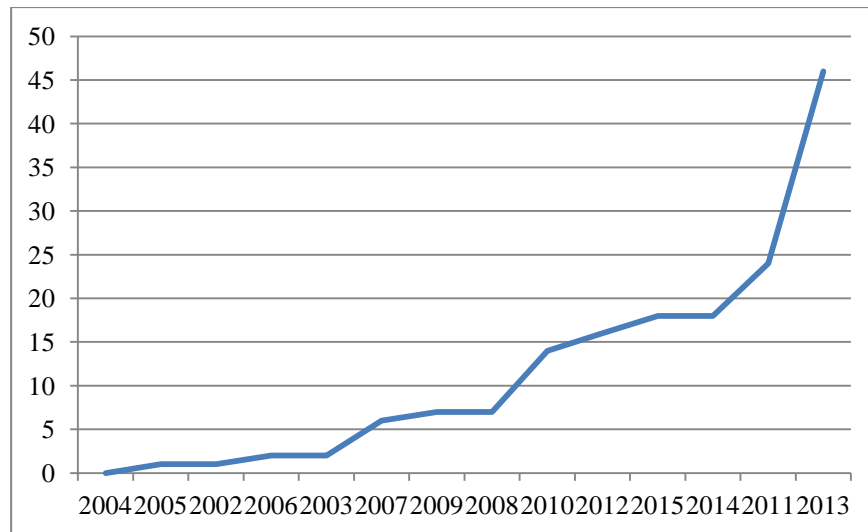
### **4.3 Start-Up and SMEs as Complementary Sources of Innovation**

Open innovation is based on outside-in and inside-out processes (Gassman & Enkel, 2004) in which several players are involved in different roles such as: SMEs, large companies, public institutions, etc...

In general, outside-in processes are defined as a set of operations aimed to enrich a firm’s knowledge base thanks to the integration with external sources (Brunswick & Vanhaverbeke, 2010; Gassman et al., 2010). SMEs may play an important role in sourcing strategy by large corporations, because they have some peculiarities. SMEs and start-ups are characterised from a lack of marketing, financial and information system resources, then a strong weakness in co-specialised assets (Teece, 1989; Lichtenthaler, 2003). These features have a strong negative effect on the sustaining of innovation. In the last decade, several scholars deepened the topic of openness in innovation, but literature has focused mainly on large corporations (Bianchi et al., 2011; Chesbrough, 2012; Hienerth et al., 2011; Huston & Sakkab, 2006; West et al., 2006). Recently, an increasing number of papers have begun to investigate the relationships between Open innovation and SMEs. Some of the more important results in literature are listed in the following figure that shows a complementary effect among large corporations and SMEs in open system of innovation.



**Figure 32:** Publication trend for to SMEs and OI literature



*Source:* based on Scopus database (2014).

Literature has acknowledged that SMEs and start-ups have strong innovation competences, both in high-tech industries and in traditional markets (Koberg et al., 1996; Santamaría et al., 2009). They are particularly oriented to breakthrough technologies, as a result of more flexible business models respect the bigger competitors (Laursen & Salter 2004). In fact, SMEs appear to be more adaptable to market needs, and usually have the ability to capture a new idea, thanks to a strong role of a leading entrepreneur. Those qualities highlight also the bonds of these firms that have a lack in managerial, financial and marketing resources who impede them to achieve the total control of the innovation process (Vossen, 1988).

Consequently several scholars suggested how they prefer to engage networking behavior, rather than complex activities of acquisition and in-licensing (van de Vrande et al., 2009), with the aim to guaranteeing an access to the missing assets and avoiding time lags, risks and costs linked to innovation (Hagedoorn, 1993).

SMEs and start-ups features tend to favor the collaboration with others players, albeit, there is a strong preference for public research institutes and universities (Brunswick & Vanhaverbeke, 2010; van de Vrande et al., 2009).

On high tech markets, a network approach, based on alliances, is considered as a crucial instrument for guaranteeing the knowledge advancement and the availability of complementary resources to the members (Bekkers et al., 2002).

Because a well-established network, small enterprises have a greater likelihood to achieve a large amount of external fluxes of information (Bougrain & Haudeville, 2002). The relationships among several organisations permit to reduce the economic impact of transaction costs, but, more important, it allows to maximise the transaction value, because the development of learning and strategic opportunity (Dyer & Singh 1998; Vanhaverbeke & Cloudt, 2014). Moreover where uncertainty is endemic on the market, companies are obliged to diversifies their sources of innovation toward a greater flexibility (Brondoni 2014; van de Vrande et al., 2006).

According to relational view (Vanhaverbeke & Cloudt, 2014), those companies that are able to collaborate in a network strategy may recombine knowledge in a new and unique manner, with the result of a superior competitive advantages in comparison with those companies based on a stand-alone strategy.

If SMEs chose for inside-out processes, thanks to out-licensing and revealing, they achieve a direct economic return, because the selling of a technology. However they incur in a dangerous disadvantage: the ‘disclosure paradox’ (Arrow, 1962).

Aforementioned paradox are produced when a licensor, who choose to sell a technology, have to deliver several sensitive information to the licensee, who may affected by an opportunistic behavior, especially when it has a superior market power or resources (Dahlander & Gann, 2010).

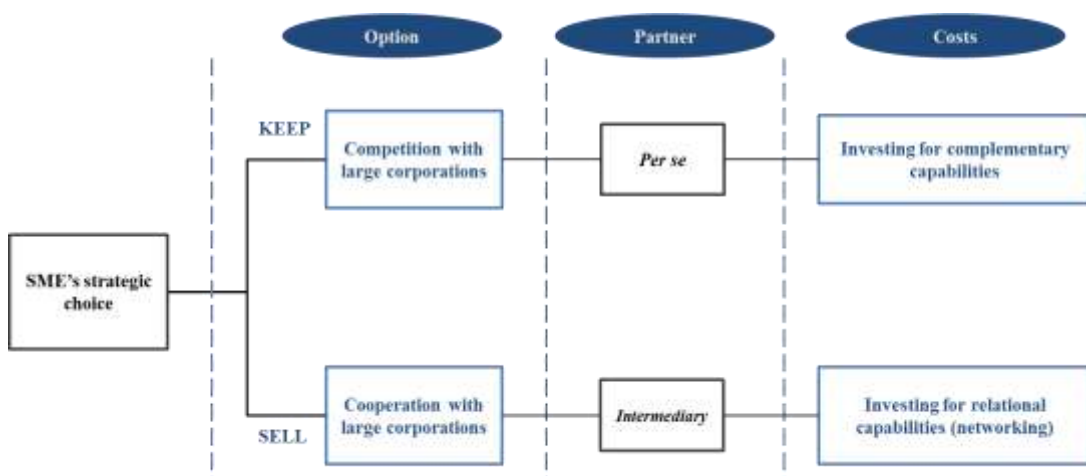
In fact, empirical evidence suggests that inside-out processes are successfully managed only by a minority of SMEs (Lichtenthaler, 2007). Also in the revealing alternative of inside-out, where companies cede their innovation in the external environment, without a direct economic return (Enkel, 2006), SMEs incur the risk to not achieve the expected benefits because the presence of a larger competitor, with a more advanced positioning and assets. Lee et al.’s model (2012) suggests that a network, in which SMEs are considered as sources of innovation, may prevent the competition, and foster the win-win approach on the relationships.

SMEs and large corporations show a complementary approach to innovation where the first act as a source of innovation of the latter, with a more open, flexible and dynamic business model.

Once that a technology are discovered by a start-up or SMEs, they have two options: sell the technology to others companies or keep it into their own boundaries and sell it in the final market, a keep or sell dilemma (Lichtenthaler et al., 2010).

The first option involves the cooperation with other organisation aimed to reach the market of technology (Arora & Gambardella, 2010). The latter bring the SMEs to heavy invest in complementary resources as manufacturing and marketing even though it may be too expensive (Gans & Sterns, 2003; Teece, 1989). Cooperation permits to avoid an unequal competition with incumbents, thanks to a relationship that involves the SMEs as technological supplier, with a complementary effect. In this manner the different features of the larger corporation (e.g. large markets and resources) and the smaller (high flexibility and high propensity in specific field of innovation). For avoiding the weakness about a size dimensions, SMEs may prefer to ask an intermediary involvement (Lee et al., 2010). Intermediaries, also called ‘innomediaries’ (see chapter 4), are able to maximise the technological market efficiency, fostering the collaboration among firms with different sizes and others players, encouraging a new business model based on ‘Connect & Develop Economy’ (Huston & Sakkab, 2006). Intermediaries support the innovation process in the safeguard of the relationships, supplying to SMEs the necessary financial and marketing resources, and to large corporations the technological advancement achieved by the smallest partners (Lee et al., 2010).

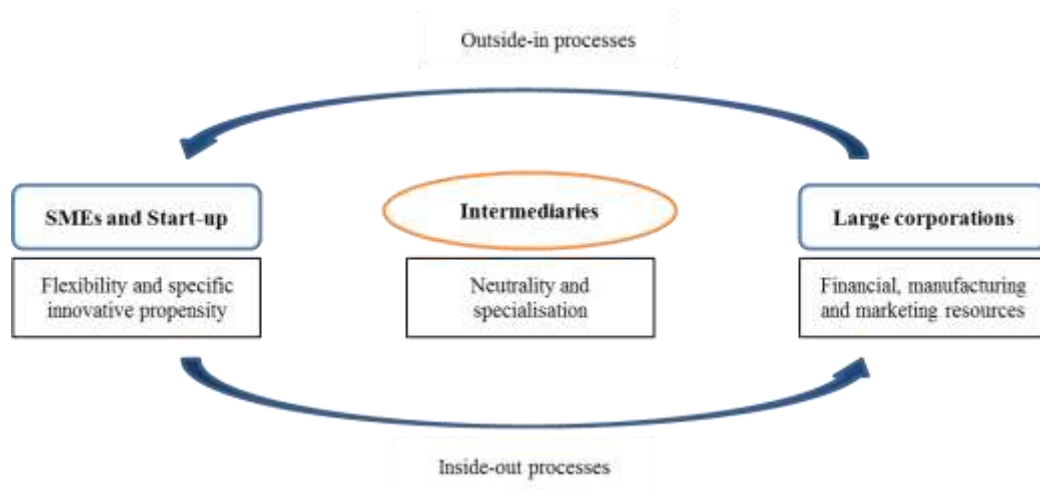
**Figure 33:** SMEs keep or sell dilemma



In the network model there are three main activities supported by intermediaries:

- collect information about technologies, markets, competitors and potential partner, thanks to the establishment of a rich database useful for the first stages of the innovation processes (Bougrain & Haudeville, 2002);
- establish a network, encouraging the strategic management or technologies, e.g. an options portfolio (Rosenfeld, 1996);
- manage the network communication, supporting the collaborative processes among the members (Luukkonen, 2005).

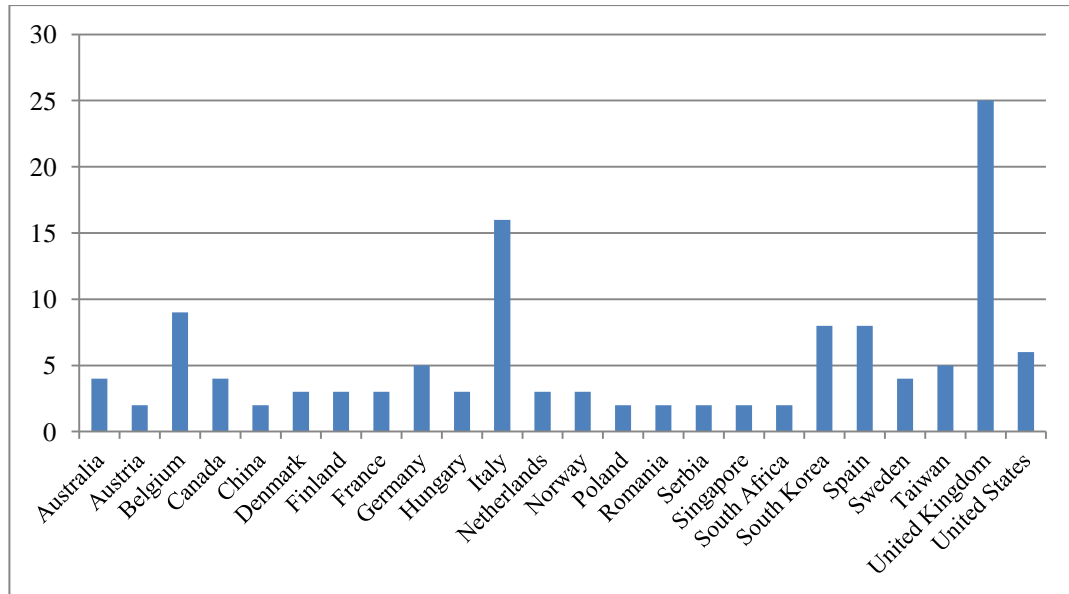
**Figure 34:** Complementarities among SMEs and large firms



The reception among supply and demand on technology market may be simpler thanks to the involvement of intermediaries, which neutrality and specialisation can augment the likelihood of a successfully result (Vanhaverbeke & Cloudt, 2014).

Also, for SMEs like for public policies, there is a strong influence from the institutional environment. Research interest is more emphasised in countries who host many small firms as the European Union.

**Figure 35:** Geographical distribution of academic research about SMEs and OI



*Source:* based on Scopus Database (2016).

European countries are more fruitful on SMEs topic because the massive presence of those organisations in the regional economic structure. In fact in several European initiative has been highlighted an encouragement for their development, also with a strong support to the definition of a start-up ecosystem able to compete against its rival overseas.

#### **4.4 Co-opetition and Inter-firm R&D**

Cooperation between competing firms is the type of innovation source more tied to the alliances literature, albeit it has not achieved an acknowledged status of paradigm in the same way as the generic network literature (Padula & Dagnino, 2007; Bengtsson et al., 2010; Choi et al., 2010). In management literature the co-opetition is considered a complementary research stream in the strategy discussion (Mariani, 2007; Walley, 2007). An important perspective about the phenomenon rewards the concept of ‘value net’ coined by Brandenburger and Nalebuff (1996) that described co-opetition as a game where firms are simultaneously cooperating to create a bigger business, while competing to split it up. The authors suggested that in the value net

there are a multitude of stakeholders such as: firms, customers and competitors. Luo (2004) included to these organisations, the important role of public sector into the value net. A point of contact with the source of innovation classification is clear if compared with the von Hippel's propositions.

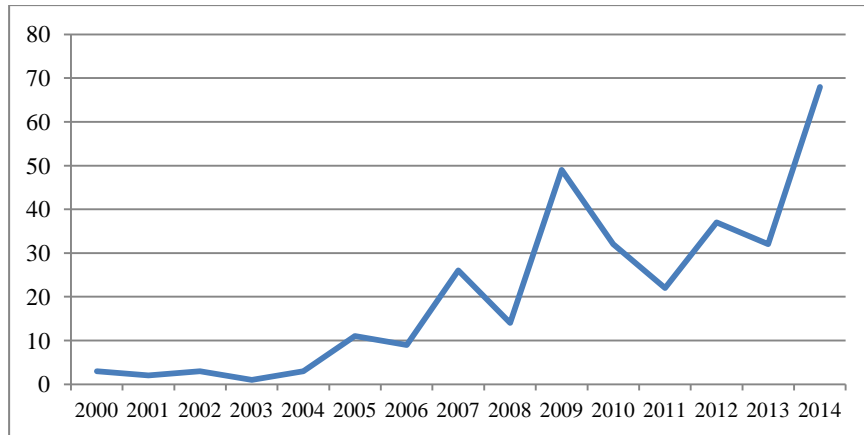
Open innovation has acknowledged that innovative process is a recombination of existing knowledge disseminated in several independent actors (Lakhani & Panetta, 2007). Competitors pursue similar objectives expressed by strategies targeted to similar geographical and product markets, and according to absorptive capacity, similar firms encourage superior likelihood to successful technology transfer (Cohen & Levinthal, 1989). Thus, once considered the faster pace and increasing cost of innovation, competing firms have begun to collaborate with the aim to reduce R&D expenditure, because the standardising of solutions, and sharing risks on new technology likelihood to satisfy the customers need (Arranz & Arroyabe, 2008; Ritala & Laukkanen, 2009).

A review of literature suggested that after the academic diffusion of Open innovation paradigm (Chesbrough, 2003), also the number of publications about the co-opetition research stream, related with innovation field, has been subjected to an noteworthy augment.

Ritala and Laukkanen (2009) suggested a literature analysis related to three research streams as: Resource-based theory, Transaction cost analysis and Game theory. Each research stream seems to highlight a different shade of co-opetition among innovative firms.

In a resource-based perspective, competitor engagement is profitable because similar knowledge base and common market vision encourage the value creation for all participants, in a superior way that for other organisations (Quintana et al., 2004; Tether, 2002).

**Figure 36:** Publications trend for co-opetition and innovation



Source: based on Scopus database (2015).

Instead, Transaction cost analysis considers co-opetition as the last fruitful solution of producing highly novel innovation on account to the lack of trust and the consequent risk of opportunistic behaviors (Nieto & Santamaria, 2007). Finally Game theory has shown a strong emphasis on positive effects for co-opetition in high-technologies industries, and has got a particular fit with new product (technology) development.

Skyrms (2004) described a game situation as follows: *“Let us suppose that the hunters each have the choice of hunting hare or hunting deer. The chance of getting a hare are independent of what others do. There is no chance of bagging a deer by oneself, but the chances of a successful deer hunt go up sharply with the number of hunters. A deer is much more valuable than a hare”*.

Deer represents a open innovation achievement, while hare is more similar to the pursuing of a stand-alone strategy innovation. Game is resolved in figure.

Skyrms’ solution of the game is a good proxy of co-opetitive behavior on global markets. A and B choice to cooperate if both believe that the sum of individual knowledge goes beyond the result obtainable by each one. At the same level, several players may choose to enjoy to the collaboration, aiming to a synergy that leaves the competitors better off than if they not been collaborating.

**Figure 37:** Game theory approach to co-opetition

Objective	Payoff	Player B		
Hunt a deer	4		Cooperate	Compete
Hunt a hare	1	Cooperate	4,4	0,1
Hunt a deer alone	0	Compete	1,0	1,1

*Source:* based on What’s in it for me? Creating and appropriating value in innovation-related co-opetition (Ritala & Laukkanen, 2009).

Once innovation was achieved by partners firms need to focus on securing the individual gain from it. Teece (1989) suggested the term ‘regime of appropriability’ in relation to “*environmental factors, excluding firm and market structure, that govern an innovator's ability to capture the profits generated by an innovation. The most important dimensions of such a regime are the nature of the technology, and the efficacy of legal mechanisms of protection*”. Firm’s ability to capture value, and profits, from innovation seems to be the most crucial factor that characterise Open innovation. Some firms, better than others, have shown this ability, obtaining satisfying market results, following the label of ‘win-win approach’. Another key factor that encourages appropriability is the setting of a standard. When many competitors support a particular technology, they are more able to support it in industry, thanks to a synergic influence, and a standard definition may produce effective entry barriers against competitors not included in co-opetition (Ritala & Laukkanen, 2009).

In the present thesis the co-opetition analysis is limited to the portion of literature tied with innovation in high-tech industries. In particular the thesis is referred to meso-level co-opetition (Dagnino & Padula, 2008) in which firms co-design and co-development R&D investments, with quicker agreement on standards, and reducing time lag. Electronics seems to be an efficient pioneer among industries, because the use of information technology, and web based technology, provide intra as well as inter-organisational information flow for supply chain management (Rusko, 2014; Huhtinen & Ojala, 2001). Mobile devices market, a global and recent example, is a suitable example of co-opetition, especially in the smartphone case. There are five steps of evolution in mobile technologies:



- the shift from analog to digital systems;
- the emergence of the mobile internet;
- the explosion of tools for multimedia content;
- the increase in processing, functionality and displays performance;
- the definition of powerful services related to wireless technologies.

High technological speed involved an market that is in constantly, and endemic, changing and often based on transformation rather than configuration and stabilization.

Rusko (2014) described the competition pattern of this market, isolating four player in a ‘war of platforms’ : iOS, Android, Blackberry and Windows Phone.

**Table 28:** Worldwide smartphone sales to end-users in 2013 (Thousands of units)

<b>Operating System</b>	<b>Units</b>	<b>Market Share</b>
Android	758.719,90	80%
iOS	150.785,90	16%
Windows Phone	30.842,90	3%
Blackberry	8.821,20	1%
<i>Total</i>	<i>949.169,90</i>	<i>100%</i>

*Source:* based on Gartner database (2014).

On global markets Android has established like leader, and it is sold with several hardware such as: LG, Samsung and Huawei. Android is a Linux-based operating system provided by Google with the Open Handset Alliance, a huge network aiming to openness and innovation in mobile devices technologies. OHA has five kind of members:

- mobile operators;
- handset manufacturers;
- semiconductor companies;
- software companies;
- commercialisation companies.

OHA membership is very diversified for geographic origin and area of competence, but surely include many competitors into a unique mission. In the Operative System case, firms established a network for reach a technology standard,

in which Samsung seems to be the best profiting organisation on global markets. Members have their own R&D units, which participate in a joint R&D in the OHA, but also develop their own contributions to their devices to the market (Rusko, 2014).

**Table 29 :** Open Handset Alliance membership by industry

<b>Mobile Operators</b>
China Mobile Communications Corporation, LG Uplus, SOFTBANK MOBILE Corp., T-Mobile, Vodafone, Telecom Italia
<b>Handset Manufacturers</b>
Acer Inc., ASUSTeK Computer Inc., Dell, FUJITSU LIMITED, Huawei Technologies, Kyocera, Lenovo Mobile Communication Technology Ltd., LG Electronics, Inc., NEC Corporation, Samsung Electronics, Sharp Corporation, Sony Ericsson, Toshiba Corporation
<b>Semiconductor Companies</b>
AKM Semiconductor Inc, Broadcom Corporation, Gemalto, Intel Corporation, NVIDIA Corporation, Qualcomm Inc., Texas Instruments Incorporated, Synaptics, Inc.
<b>Software Companies</b>
eBay Inc., Google Inc., LivingImage LTD., Nuance Communications, Inc., SkyPop, SONiVOX, VisualOn Inc.
<b>Commercialisation Companies</b>
Accenture, Borqs, Intrinsic Software International, Noser Engineering Inc., Sasken Communication Technologies Limited, SQLStar International Inc., Teleca AB

*Source:* based on Android Website (2015), consulted on March 15th 2015.

Cooperation take place at the first stage of the relationship, followed by a phase of competition on the market. Those meso-level relationships involve two kind of effects. First, a voluntary disclosure of technologies by each firm, who at the same time may learn by others. Second a set of involuntary spillovers take place among organisation, and incentivize to opportunistic behavior (Ritala, 2010).

## Chapter 5

# Open Innovation and Networks

### 5.1 Barriers to Innovation

Real option theory suggests that a firm has to support a network which several sources of external knowledge can sustain innovation. At the same time, Open Innovation and corporate networks, are widely approached from the recent literature as a successful methods to reach high performance, but many firms tried to face their challenges and failed. Few scholars have investigated about the reason why some firms had difficulties in managing inter-organisational relationships whereas others seemed to be quite sure about their functioning. The present thesis aim to deepen the OI processes both in its advantages and in those caveats who make difficult the managerial paradigm implementation.

Chapter two discussed the importance of the cultural dimension about openness and underlined as how the transformation from closed to open business models may be adopted only by firms high committed at the top managerial level. In fact as stated by Gassman et al. (2010) *“opening up the innovation process starts with a mindset”*. However there are many reasons to trust in a closed approach and many top managers seemed to be suspicious about the trade-off between openness advantages and risks. Many firms toke the liberty to don't explore the phenomenon because the industrial environment and had chosen for a gradual implementation on inter-organisational efforts, others are obliged by aggressive competitors to abandon the safeties about their traditional closed business model. However, all innovative firms have to consider the challenge brought by one of the most important topic in innovation management. According to OI research stream, the highest degree of openness are totally reached by firms able to manage both outside-in processes and inside-out. Several organizations are placed in an intermediate position because employ only parts of these processes, and they are not already prepared to discover

other frontiers. In fact, to manage a whole network of sources of innovation, with the correlated relationships, involve high costs of learning and implementation and high specialised skills into the firm's boundaries. Start-up and SMEs usually have the right cultural approach but find in their lack of assets an insurmountable bond to openness. Instead, large firms may trust on strong resources to invest but they haven't the sufficient strategic flexibility to overcome a conservative approach.

Barriers to Open innovation are impediments referred to the unwillingness to undertake inter-organisational knowledge transaction (Chesbrough & Crowther, 2006; Lucas & Goh, 2009). According to the degree of openness, different forms of limitations can occur the firm. Those organisations interested to outside-in processes may be affected by a negative attitude toward the utilisation of external ideas and technologies: the Not Invented Here Syndrome. Firms are usually skeptic about an external locus of knowledge, especially when they expend large amount of financial resources in internal R&D projects, or when they have a long and virtuous history like innovators. Those firms interested to inside-out processes may be suffer a negative attitude to publicise their own knowledge to others, a form of resentment also acknowledged as Not Sold Here Syndrome. These syndromes largely affect the possibility to successfully manage a process of openness with a success because part of the employees, dedicated to inter-firms relationships, may prevent the top management's instructions. Scarcity and inconsistency by literature show a strong point of interest for exploring this side of innovation so tied with the collaboration with many partners. Only few studies like the one argued by van de Vrande et al. (2009) supplied an empirical evidence of how the cultural issues are relevant to establish a wall against Open innovation strategy, while other scholars deepened the issue on the basis of anecdotal evidences and theoretical propositions. Answering to this issue is important to focus on the right object, that is the employees willing to receive and share knowledge with external partners.

As in the absorptive capacity also these syndromes are founded primarily on individual predispositions to respond to given stimulus. In a firm, because of social relations, employees develop a social predisposition that may diminish or augment the favor referred to a particular initiative (Burcharth et al., 2014; Crano & Prislin, 2006). This predispositions evolve into attitudes that are embedded in the corporate

culture and also influence the approach to the innovation culture (Herzog & Leker, 2010). Innovation culture is a valuable resource that is intangible and difficult to imitate, but at the same time, it may be hard to change in a new perspective. In fact, there are several constructs under innovation culture (e.g. market, technology, learning, entrepreneurial orientations) and each of them is strictly tied to the openness issue. A pro-active R&D approach has to consider features such as (Herzog & Leker, 2010):

- encouraging risk-taking;
- researching new ideas;
- tolerating failures;
- encouraging learning and training;
- promoting constructive critiques.

Open innovation doesn't exclude these features but promote other dimensions related to overcome the closed dimension of the firm's business model. Top managers may be able to promote the right values, but have to consider their employees predispositions.

For each new stimulus an employ doesn't respond with a new answer but it usually acts according to the predisposition. As a result when top management put the new strategy to open up the innovation process, the social answer provided by employees may be, also not intentionally, a refuse.

However the barriers to a new approach can exceed the employees level. Chesbrough (2007) suggested many reasons of managerial opposition to new business models. At the highest level CEO typically delegates responsibilities on business model to a general manager, that in large firms is subject of short-run rotation (two or three years), and is obliged to follow the established way to create value. Also, each chief officers need to be involved in order to guarantee the whole implementation of the new business model.

Before the detailed analysis of the NIH syndrome there are some premises to do, in order to better frame the context in which firms manage their knowledge base. Lichtenthaler and Ernst (2006) suggested a six attitudes framework based on the firm's predisposition to face internal sources of innovation. Authors started from the

main studied NIH and suggested several effects referred to the managerial approach over three situations.

**Table 30:** Chief officers tasks in OI implementation

Chief officer	Task
<i>Financial officer</i>	Measuring and communicating the financial results of the new model.
<i>Legal officer</i>	Safeguarding the intellectual property rights in relation to technology transfer.
<i>Technology officer</i>	Promoting and monitoring the new innovation processes.
<i>Marketing officer</i>	Promoting user engagement and focusing on new or established markets.

*Source:* based on Business model innovation: it's not just about technology anymore (Chesbrough, 2007).

First, in the outside-in processes they focused on knowledge acquisition and stated two alternative attitudes toward external sources: a negative attitude to external knowledge (NIH) and a positive one (BI). As early stated the former has a stronger detailed study and will be examined in the next section, whereas the latter, represent a positive distortion based on a lack of confidence in the firm's own innovation capabilities or on an overestimation of the external sources. BI is an example of a culture of openness but characterised by wrong methods of execution. As stated in the chapter two, Open innovation is strictly tied to absorptive capacity (Cohen & Levinthal, 1990) and the BI may conduct to inappropriate assessments of external technologies or in increasing coordination cost, because a dangerous dependence from external partners.

During the knowledge accumulation Lichtenthaler and Ernst (2006) suggested other two alternative attitudes: the ASH and the RO. ASH represents a closeness about the possibility to enrich our knowledge base with external input.

**Table 31:** Attitudes to knowledge management

<b>Knowledge Acquisition (Outside-in)</b>	
<i>Internal</i>	<i>External</i>
<i>NIH</i>	<i>BI</i>
<b>Definition:</b> An attitude to the external acquisition of knowledge that is more negative than an ideal economic attitude would be.	<b>Definition:</b> An attitude to the external acquisition of knowledge that is more positive than an ideal economic attitude would be.
<b>Solution:</b> Organizational incentives, information and communication aimed to promote openness.	<b>Solution:</b> Neutral assessment of benefits and costs about external knowledge sources.
<b>Knowledge Accumulation (Outside-in)</b>	
<i>Internal</i>	<i>External</i>
<i>ASH</i>	<i>RO</i>
<b>Definition:</b> An attitude to the external accumulation of knowledge that is more negative than an ideal economic attitude would be.	<b>Definition:</b> An attitude to the external accumulation of knowledge that is more positive than an ideal economic attitude would be.
<b>Solution:</b> Gatekeepers and promoters focused on promoting openness; Increase the coordination and integration between internal R&D and external knowledge.	<b>Solution:</b> Detailed assessments of inter-organizational relations; Definition of which areas of knowledge need for an external contribution.
<b>Knowledge Exploitation (Inside-out)</b>	
<i>Internal</i>	<i>External</i>
<i>NSH</i>	<i>SO</i>
<b>Definition:</b> An attitude to the external exploitation of knowledge that is more negative than an ideal economic attitude would be.	<b>Definition:</b> An attitude to the external exploitation of knowledge that is more positive than an ideal economic attitude would be.
<b>Solution:</b> Establish incentive systems and promoting the advantages from out-licensing and revealing.	<b>Solution:</b> Enforce the control over the commercialization of technologies and invest in coordination between internal and external use of knowledge.

*Source:* Based on Attitudes to externally organising knowledge management tasks: a review, reconsideration and extension of the NIH syndrome (Lichtenthaler & Ernst, 2006).

It is caused by a lack of trust in potential partners and lead to a scarce use of the inter-organisational relationships, with the risk of lose the ability of networking.

Instead, RO is an underdevelopment of the internal knowledge base because an excessive use of external flows. Also in this situation the absorptive capacity is damaged because firm's employees tend to lose the skills to acknowledge the valid external sources.

At the end of the model there are two attitudes emerged during the knowledge exploitation phase: a negative attitude to the exploitation of knowledge (NSH) and the opposite attitude SO. The latter depends on an overvaluation of the direct (monetary) and indirect (strategic) benefits from out-licensing and revealing processes. The worst consequence of this attitude is the impoverishment of the firm's best knowledge because several innovation is ceded to other market players as the competitors.

## **5.2 Not Inveted Here Syndrome**

Inbound processes request commitment also in the cultural perspective and opening up the innovation process starts in the highest level (Gassmann et al., 2010). Openness is understood as a general willingness to access new knowledge, a positive attitude towards complementary influence, and, consequently, the willingness to exchange with others (Enkel, 2010). Openness inside the network improves each member's knowledge about what he/she does not know and what the partners know (Macdonald & Piekkari, 2005) but these also involves the minimisation of opportunistic behavior. At the basis of the Real option implementation there is the premise that firm is favorable to accept and approve the external knowledge. Instead, many companies failed the correct approach in following OI because they neglect to ensure that the outside ideas reach the people best equipped to exploit them (Whelan et al., 2011). To benefit from external sources, firms need to identify such innovations, maintain the absorptive capacity to understand them, and be able to combine such spillovers with firm-specific internal innovation to produce a product tailored to the firm's specific needs (West & Gallagher, 2006). The first phase of this outside-in process requires the honest evaluation of the others innovative skills but it, often, doesn't happen. Understanding the dynamics of acquiring process request to



deepen the mitigation effects caused by the company’s predisposition. Not Invented Here Syndrome (hereafter NIH) is the most studied firm’s attitude to innovation. Even though this syndrome finds its roots in sociological and psychological branches of knowledge, in the last years, it has been reconsidered in the innovation management research stream, especially in consideration of those firms aimed to absorb technology from external sources.

However literature about NIH is desultory, cross-disciplinary dispersed and discontinuous, even if there are several empirical studies about its effect on performance.

In the following table will be listed the main literature contribution (Table 33):

**Table 32:** Main studies for NIH

<b>Argumentation</b>	<b>Source</b>	<b>Type</b>	<b>Method</b>
Individuals may prevent NIH	Clagett, 1967	Master thesis	Case studies, Anecdotal
Team tenure influence NIH	Katz & Allen, 1982	Journal paper	Empirical
Nurturing special talents is a cause of NIH	Burcharth et al., 2014	Journal paper	Empirical
NIH or positive effects act in knowledge management cycles	Lichtenthaler & Ernst, 2006	Journal paper	Theoretical
Attitude of professors may generate NIH	Kathoefer & Leker, 2011	Journal paper	Empirical
The preference for outsider knowledge as a positive bias	Menon & Pfeffer, 2003	Journal paper	Empirical

Literature review, from different research streams, suggest that there are many perspective but, at the same time, likewise common fundamentals, as the prior definition as *“the tendency of a project group of stable composition to believe it possesses the monopoly of knowledge of its field, which leads it to reject new ideas from outsiders to the detriment of its performance”* (Katz & Allen, 1982, p. 7) or the lasts as *“a negative attitude of employees against externally developed knowledge”* (Hussinger & Wastyn, 2015). Reminding the Chesbrough’s definition (2003) *“Open innovation is a paradigm that assumes that firms can and should use external ideas*

*as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology*". These two concepts, NIH and OI, are strictly linked, but even if the former was positively considered by academics and practitioners, not always firm's employees are of the same idea about openness toward external sources (Katz & Allen, 1967). Each firm is characterised by an own culture that is the top basic foundation about it, barely imitable, intangible assets (Brondoni, 2002). According with Gatti and Cesareo (2012) corporate culture is a set of rules who a group of colleagues develops in order to orient a new individual in the organisation. Following this set of rules a new individual will be accepted by other employees. The whole firm use the corporate culture for setting the relationships with the external environment, and it is fragmented in a set of routines useful to enable the problem solving into the organization's team with the aim to seek, access, recombine and exploit the knowledge (Nelson & Winter, 1982). According with Social identity theory, the acceptance or reject of these routines identifies which subjects belong with which group and how each person acquire its self-concept and self-esteem (Tajfel, 1974). The comparison among internal and external sources of innovation also involves the comparison and the evaluation of those routines, that sometimes fear the external knowledge as a threat. When the members of a group feeling their identities under an external pressure, they usually tend to show a protective behavior toward their own organisation (Hussinger & Wastyn, 2015). In particular, NIH shows two functions (Arias-Perez et al., 2016): a knowledge function which employees give more importance to capturing ideas from a setting rather than from an external one that deviate from personal experience (Knudsen & von Zedwitz, 2003). According with Agency Theory, NIH has an utilitarian function which individuals are characterized from opportunism in protect their personal interests and avoid situations that jeopardize them (Bohner & Dickel, 2011).

A larger identification of a member in its group involve increasing tendencies to an in-group favoritism and also, to a defensive attitude against the external knowledge. On the contrary, a lack of member identification with the rest of the group involve a scarce awareness of the group identity, and also, a littler willingness to defend the group (Jetten & Spears, 2003). Such behaviors are usually promoted by culture aimed to support the group identification as an instrument to favor the coordination

and the trust development inside the group, encouraging the intra-group relationships (Glaeser et al., 2000). Behind the dangerous features of NIH there is its unconscious disposition. In fact, it is so developed that afflict also the colleague-to-colleague relationships when an employ searches information and ideas in other realms of its firm (Burcharth et al., 2014).

Once described the functioning of NIH syndrome, a more cogent connection with the innovation management, in particular analysing which firms are more exposed, which sources may be worst perceived and which solutions are available by top management with the goal of moderate its negative effect.

Large companies seem to be more suffering about the NIH (Agrawal et al., 2009). In fact, large firms usually face high competitive industries with high degree of obsolescence and convergence where the creation of strong routines and intangible assets help them to survive. Larger dimensions involve an increasing number of self-citation, and when they are isolated leader in a determined geographical area, there is an increasing myopia toward external knowledge (Agrawal et al., 2009).

Good reputation may be another motivation of resistance against external knowledge because successful and positive performance increase the attractive and distinctive dimension of a group (Dutton et al., 1994). In fact, more is the firm successful and more is the satisfaction that an employ receive by the membership, and hence, more is the sense of threat perceived by a comparison with external partners. The top of mind firms as ideal workplaces (e.g. Google and Facebook) in the global ranking suggest that some companies are more attractive than others because the internal environment quality. As a result of these two reasons to NIH in large firms, organisations that were highly successful at the integrated innovation model will tend to believe its innovations superior to any competing ideas from outsiders (West & Gallagher, 2006).

SMEs seems to be less suffering the NIH because they are more flexible and show an attitude to act following the network model (van de Vrande et al., 2009).

A so virtuous behavior may depend from the lack of complementary assets that oblige them to collaborate with larger firms, that are able to guarantee financial and marketing assets in support to innovation (Teece, 1986).

Nevertheless also SMEs are affected by skepticism in opening up their boundaries to external partners and they prefer to engage relationships with universities and research centers rather than other private subjects (Brunswick & Van Haverbeke, 2010).

Independently by the firm size, Perez et al. (2016) argued that innovation capabilities can reduce the NIH negative effect. Innovation capabilities are defined as organizational routines, hence dynamic capabilities, able to help companies to achieve new resources when market change. As a result the authors consider these capabilities like a means to lead employees to adopt an open behaviors toward external partners. Because of innovation capabilities firm can mold its employees in order to obtain a sense of social norms and reciprocity and because their self-interests are cooperatively correlated (Tranekjer & Knudsen, 2012; De Araùjo et al., 2014; Huizingh, 2011).

Another feature that influence the NIH concern the heterogeneity of the innovation sources. Hussinger and Wastyn (2015) demonstrated that the syndrome tend to augment when firms engage a relationship with a competitor. Competitors have usually high homogeneity of cost structure, technologies and knowledge. This similarity involves an increasing perception of a threat of comparison, because the counterpart may show better capabilities that may shed a grey light over the internal routines. Last considerations highlight a paradox between what is proposed by absorptive capacity in terms of complementarity. Substantially, firms are more able to absorb greater quality and quantity of knowledge by competitors but their employees are more hostile because they prefer to avoid the comparison with their counterparts.

Conversely, a better likelihood for acquiring knowledge from external sources occurs when the partners have (Ashforth & Mael, 1989):

- different competencies;
- complementary competencies;
- inferior competencies.

Finally, each firm has different degree of openness for new ideas and knowledge but NIH syndrome support the hypothesis that the network perspective about Open innovation require a strong commitment at the highest cultural and managerial level,

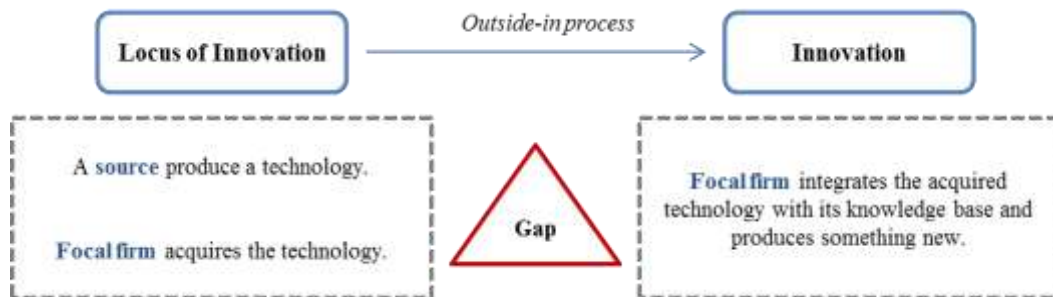
with an internal communication effort aimed to overcome the organisational barriers about new ways to produce value by the innovation process.

### 5.3 Innovation Intermediaries

Networking in innovation may be a difficult task because the central good that is traded seems to be the innovation itself. Instead, a key basic assumption under openness is the distinction between source, or locus, and the transformation of it in an innovation. In outside-in processes (e.g. sourcing and acquiring) firms absorb technologies and ideas from external partners, but this is only the beginning of the innovation process. Ideas have to be integrated with the current knowledge base and firms have to understand how employ them into their business models. In inside-out processes locus of the innovation is placed inside the business' boundaries, but firms prefer to cede it toward other organisations that exploit it and may produce the real innovation.

Both the kind of processes highlight the existence of a gap made up by the locus of innovation and the moment in which innovation is produced (Figure 38).

**Figure 38:** Gap between locus and innovation



There are several motivations of this gap that represent strong impediments to Open Innovation. First, focal firm may be unaware about the existence of a new technology that is coherent with its own business model. In several industries sources may be so diffused and articulated that a firm struggles to reach all the information available in the external environment. A new idea proposed by an user, or an

emergent start-up with new technological advancement, is not always easily recognisable. As stated in the chapter two, the information system through specific dedicated figures has an important role of screening the environment but, at the same time, the efforts doesn't exceed the benefit from sourcing. In fact, information about customers and competitors must be monitored because the existence of new products and technologies (Brondoni, 2014; Lambin & Brondoni, 2001). As a result more are limited the efforts in screening, and more are the likelihood to be unaware about potential sources of innovation.

A second bond is the paradox of disclosure, an emergent issue in intellectual property management. Paradox occurs when a firm use its inside-out processes (i.e. licensing) ceding a part of its knowledge (i.e. technologies, ideas, patent,...) to another company. In this breakable moment the licensor has to disclose the technology functioning and need to sell its product, and at the same time, it doesn't reveal information useful to the licensee to replicate the technology without the acquisition.

As a result firms need for overcoming these bonds that limit the network model for innovation. Lee et al. (2010) suggested that the intermediary adoption is useful to maximise the network functioning, because the role of a third party may avoid some technology markets imperfections. Intermediaries are able to favor the collaboration among several network's poles and, so doing, to simplify the concept of 'Connect & Develop Economy' (Huston & Sakkab, 2006).

An intermediary provides four different supports to the network:

- collect sensitive information about technologies, markets, competitors and potential partners, avoiding the first type of limitation about the unawareness of potential opportunities and threat (Bougrain & Haudeville, 2002; Fontana et al., 2006);
- play an adhesive role among network actors, favoring, in a real option perspective, the strategic management of technologies (Rosenfeld, 1996);
- improve the quality and quantity about the relationships inside the network in a more open, flexible and dynamic way (Luukkonen, 2005).
- provide a point of contact among demand and supply of knowledge.

For each firm who act with inside-out processes, there is another one that must to develop the mutual outside-in ones. Intermediaries are fundamental for allowing that each part may achieve the right benefit in a network.

Billington and Davidson (2012) defined intermediary as *“a formal or informal collection of people or companies that facilitates a productive working relationship between two previously unconnected parties”*. Also the definition provided by Hargadon (1998) is coherent with the present interpretation as *“organizations that span multiple markets and technology domains and innovate by brokering knowledge from where it is known to where it is not”*.

Hence intermediary is not an univocal figure. In the past, different forms of intermediaries has been acknowledged, according to the task that they accomplished. In the chapter four there are several form of external sources of innovation and each one asks for different support for matching the focal firm need. User innovation is an important example of how companies need for an intermediation by high skilled organisations able to reach a vast number of possible innovators. For example, without intermediation, firms need for establishing a section in the own web site useful to receive a community of solvers. Beyond the technical dimension, a strong communication efforts will be done because nobody knows the existence of the new community which they may propose their technological solution to a specific issue. The costs of collect people, manage them and supply time-based and quality feedback can be an impediment to the start of user engagement. This set of reasons explain because firms usually prefer to call a specialised player that already has a strengthen users base, before profiled and instructed of how participate in crowdsourcing activities.

Literature has deepened the intermediation under user innovation perspective (Chesbrough et al., 2006; Enkel et al., 2009; Gassman et al., 2010; Luman & Dodson, 2006; Antikainen & Vaataja, 2010; Antikainen & Mäkipää, 2010) and one of the better example is Ninesigma, founded in 2000 by Mehran Mehregany with the goal of supply a point of contact among firms with technological issues with a large community of potential providers. Ninesigma’s network is the largest innovation platform with a community of more than 2 million solution providers spread at a

global level. Ninesigma is strictly tied to the OI paradigm that is a theoretical support of the company's business model (Table 34).

**Table 33:** Ninesigma: vision and mission

<b>Vision</b>	<i>We will drive both positive cultural change and business success by introducing new collaboration models that help change the world.</i>
<b>Mission</b>	<i>By sharing our collaborative innovation experience with our clients, providers, partners and colleagues we will forge long-term relationships that result in shared market success for all.</i>

*Source:* based on Ninesigma website (2016), Ninesigma's Vision & Mission Statements, consulted on February 15<sup>th</sup> 2016, available at: <http://www.ninesigma.com/ninesigma-overview/ninesigma-s-vision-mission>

Companies that would benefit from the intermediation have the access to the Ninesigma's community, Ninesights, that include several instruments such as: blogs for technical discussions, resources and activities to develop with the users. According to the literature, the intermediation offers a point of contact for demand and supply of knowledge. Moreover in this specific business case there are all the benefit caused by the interaction with a well-established community (Gnecchi & Corniani, 2003).

Anecdotal evidences show a positive contribution from intermediation as the case of Goldcorp, that published the geological data about its Red Lake Mine, and offered a pecuniary prize of 575.000 dollars to the person, or company, able to supply a way to improve the mine productivity (Tapscott & Williams, 2006; Billington & Davidson, 2012). As a result two Australian firms provided a new solution and Goldcorp succeeded in its purpose.

Intermediaries are useful to fulfill the gap between the focal firm and the potential partners, because have a more extended point of view of which knowledge has each subject.

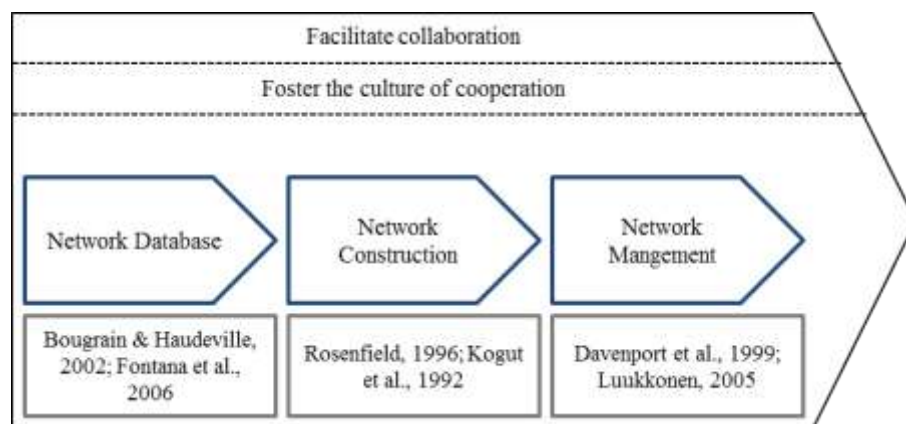
Literature in intermediation from a network perspective was well summarised by Lee et al. (2010) who proposed a model based on the assumption of Open innovation. Lee's model was built upon three direct activities:

- build a network database collecting information about knowledge in order to identify the appropriate partners for each need.



- build the network itself assisting firms and other organizations in knowledge transfer and improving IP management.
- support the network management avoiding barriers to cooperation.

**Figure 39:** Intermediary roles in the innovation process



*Source:* based on Open innovation in SMEs—An intermediated network model (Lee et al., 2010).

Also, the authors suggested the crucial role of two indirect activities as support of the three main ones, such as foster the culture of cooperation and facilitate collaboration among the network players. The role of intermediation aforementioned are consistent with the propositions provided by the authors.

It is clear that the complexity of relationships caused by the Open Innovation implementation involves several issues about inter-firm exchange of knowledge in which, intermediaries of different disposition, may be able to increase the functioning of those networks that aim to open up their innovation process.

#### 5.4 Competition among Innovative Networks

According with Real option theory and Open innovation, those firms that aim to accelerate and improve their innovation process have to become part of a network. This thesis is considering the network from a focal firm perspective, but in global markets, competition leaves the firm-level and reach a higher degree of inter-firm integration, establishing a network-based competition.

As stated before, electronics markets because their convergence dynamics, obsolescence and high R&D costs, are a quite field of implementation of openness and networking. In fact it is hard to distinguish if the market leadership in a product is tied to a single firm, or to the ability of that firm to maximise the benefits from the belonging to a network.

Modularity and complexity in modern products (Garbelli, 2005) involve an increasing bundle effect in which customers are unable to distinguish the value contribution of each product feature. In chapter two, was described how the vertical integration model, which a unique manufacturer managed all the innovation process, failed to survive in a competitive market. As a result many electronics markets faced the industrial complexities with a networking strategy where each network player share, with its partners, different contribution. In many examples the foundation of a stable inter-firm collaboration produced the creation of other networks as a strategic response. Despite some of these inter-firm organisations didn't reach a formal agreement, an articulated net of strategic alliances and R&D pools was established. Hence electronics markets, and in general innovative industries, are characterised by a network-to-network competition. In these competitive pattern innovation is the output of the network rather than the single firm.

Anecdotal evidence showed several examples of this behavior such as Android, who is a formal network established by companies spread a global level, or the Nokia Research Center who is a net of universities and research centers with different domains of study useful to Microsoft in hi-tech technologies. Asian larger corporations as LGE and Samsung Electronics are preferring a more cogent agreement where usually partners will be incorporated into the main *chaebol*. Each network has a own organisational structure and it is more or less object of communication for the customers, but all of them are built around the same type of sources of innovation.

Finally, according with the literature guidance proposed in the previous chapters it is proposed a framework of a network structure able to foster Open innovation, through the following members:

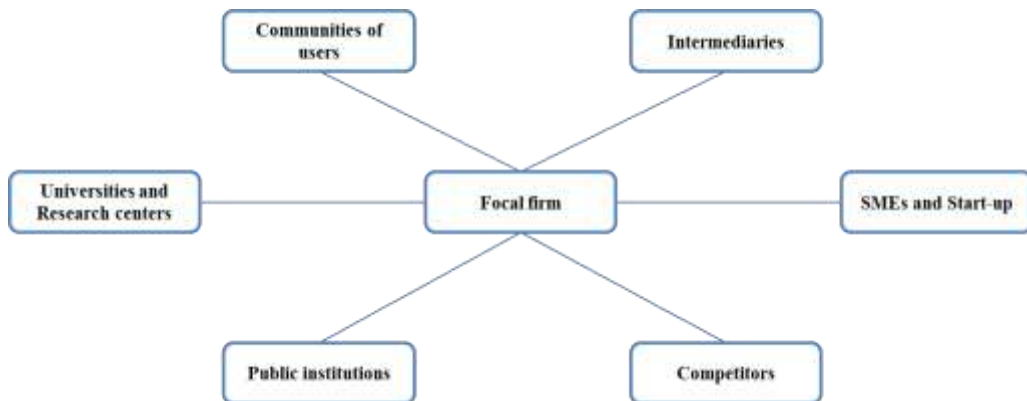
- focal firm;
- universities and research centers;

- communities of users;
- intermediaries;
- competitors;
- small and medium enterprises and start-ups;
- public institutions.

If in the chapter four is presented how this network's members are useful as external source of innovation, in the present section was deepened their role inside the network, keeping a focal firm perspective.

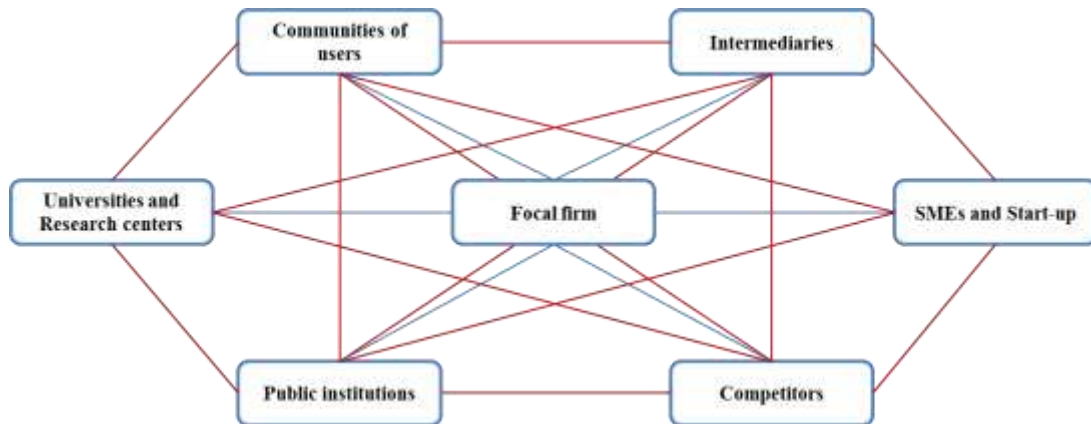
Figure is based only on the set of relationships tied with the focal firm, but each organization is widely connected with the others under different level according to many conditions such as national politics, corporate culture and strategic goals.

**Figure 40:** Innovative network from a focal firm perspective



For example public institutions are strictly linked to universities and research centers because public funding heavily influenced the relationships among public research and firms. Also, in Europe several organisations were established with the aim to help and promote a start-up ecosystem able to support the development of the relationships among large corporations and new hi-tech enterprises.

**Figure 41:** Set of relationships for an innovation-based network



At the present degree of analysis all the chapters of the present thesis may be summarised in a framework of innovation network, that is based on the following main activities:

- 1) create many technology options toward different external source of innovation;
- 2) integrate with internal R&D those technology options considered as coherent with firm's business model;
- 3) cede the othr technology options inside the network or in the market for technology;
- 4) produce innovation as an outcome from collaboration among all the network members;

The four activities may be seen as a continuative cycle that is the result of the Open innovation implementation inside a network-to-network competition.

## Chapter 6

# Open Innovation in Samsung Electronics

### 6.1 A Company Overview

Samsung Electronics Ltd is a large part of the South Korean giant popular as Samsung Group, a big *chaebol* that compete in various industries such as: electronics, engineering, chemistry and financial services. Etymology was originated by the combination of two words from the Korean naja Sam(삼) Sung(星) intending the adjectives great, powerful, universe and immortality. Group has a past under the name of Cheil, established in the 1938 by Byung-Chull Lee. According with the Korean investment in public and private industries, Samsung during the seventies invested in a large array of activities, but since the beginning of the eighties waited for the tangible technological diversification. At the end of the nineties Kun-Hee Lee began a wide reorganization putting the goal to compete at the highest level on electronics markets. Because the strong empowerment of competitive positions on several markets, Samsung overcame the crisis in 1997 with strong interventions about the organizational structure and on financial indebtedness<sup>1</sup>.

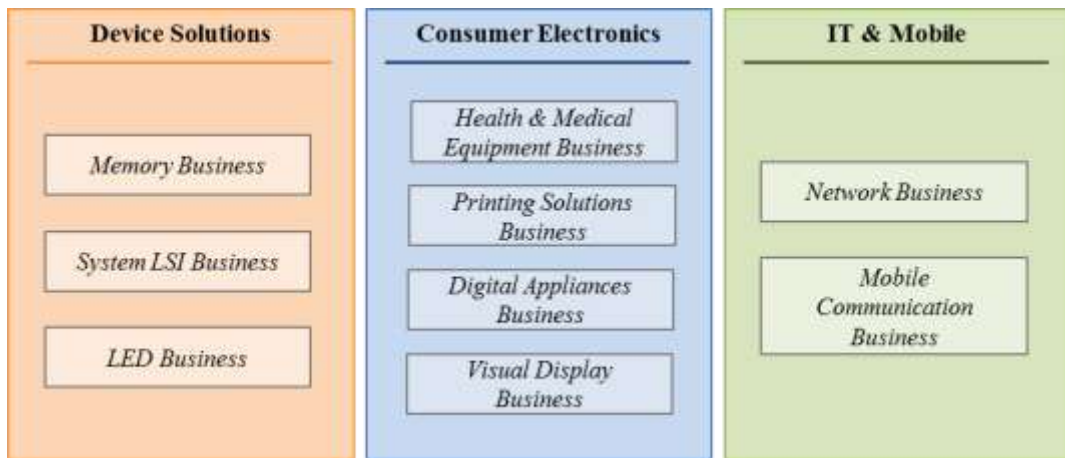
Although all the group is solidly oriented to an innovative vision as “*inspiration for the society future, create a new future*”, in the present thesis will be analysed not all the Samsung Group but only the part constituted by Samsung Electronics Ltd.

Samsung Electronics competes in several industries where the push factors for Open Innovation are well settled such as: convergence, obsolescence, imitation and time-based competition. In particular it distinguished the corporate business overview in three strategic divisions displayed in figure 42.

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<sup>1</sup> Decrease of indebtedness from 365% to 148% in two years

**Figure 42:** Samsung: business overview



Source: based on 2014 Samsung Electronics Annual Report.

In all markets in which it competes, Samsung Electronics achieved strong global market positions as a result of an advanced innovation process. Company obtained these egregious results thanks to a wide trust in its R&D orientation and because it has widely involved partners as source of innovation. Table 36 shows some market performance in which Samsung showed a positive response to the dynamic changes of the more and more industrial blurring.

**Table 34:** Samsung performance in global markets

Business	Market	Performance	Market Share
<i>Consumer Electronics</i>	Visual Display	Leadership for all flat panel tv product lines	28,30%
		Leadership for tvs larger than 60 inches	39,10%
		Leadership for UHD technology	34,30%
	Digital Appliance	Leadership for home appliance	--
	Printing Solution	Second market player for A4 laser print	15%
<i>IT &amp; Mobile Communication</i>	Mobile Communication	Leader for mobile phone	22,10%
		Leader for smartphone	24,70%
<i>Device Solutions</i>	Memory	Leader for DRAM memories	40,40%
		Leader for NAND flash memories	36,50%
	System LSI	Leadership for DDI	18%
		Leadership for CMOS image sensor	20%
	LED	Leadership for LED tv module	8%

Source: based on 2014 Samsung Electronics Annual Report.

At the basis of these excellent performance must be considered various characteristics. Firstly in the present thesis were excluded corporate governance considerations because they are out from a research questions perspective. The only suggestion from a rapid outward of the Board of Director shows an usual Korean large *chaebol*.

**Table 35:** Samsung: board of director

Name	Title	Responsibility	Tenure from
<i>Oh-Hyun Kwon</i>	Vice Chairman & CEO	Chairman of BOD / Head of Device Solutions Business	2012
<i>Jong-Kyun Shin</i>	President	Head of IT & Mobile Communications Business	2013
<i>Boo-Keun Yoon</i>	President	Head of Consumer Electronics Business	2013
<i>Sang-Hoon Lee</i>	President	CFO / Overall management support	2012
<i>Eun-Mee Kim</i>	Independent Director	Independent director	2013
<i>Han-Joong Kim</i>	Independent Director	Audit socommittee, Related party transactions committee, Independent director recommendation committee, CSR committee	2012
<i>Kwang-Soo Song</i>	Independent Director	Audit socommittee, Related party transactions committee, Compensation committee, CSR committee	2013
<i>Byeong-Gi Lee</i>	Independent Director	Independent director recommendation committee, Compensation committee, CSR committee	2012
<i>In-Ho Lee</i>	Independent Director	Audit socommittee, Related party transactions committee, Compensation committee, CSR committee	2010

*Source:* based on 2014 Samsung Electronics Annual Report.

Board of Directors composition is similar to other Asian large firms with a strong presence of a male and Asian component. Instead, a set of features interesting about these research questions are the relationships established by Samsung with other sources of innovation, and hence the network itself. There are three levels in the Samsung networking: production, sales and the part tied to innovation and R&D, that is the focal unit of analysis. Production network accounts for 38 poles spread in Asia,

in particular: China (13 structures) and South Korea (5 structures), India, Vietnam and Malaysia (2 structures), Indonesia, Philippines and Thailand (1 structure). Following the prevailing production activities placed in Asian countries there are 4 structures in Europe, 1 in South America and 2 in the United States.

Sales network is built on 54 poles globally diffused in Pacific Asia (20 structures), Russia and central Asia (3 structures) and Europe (17 structures). Because the network tied to innovation is the goal for this discussion the following section is entirely aimed to examine in depth the R&D management.

## 6.2 Internal R&D and Knowledge Management

Great performance in hi-tech industries have to be sustained by a strong capability in the R&D and knowledge management. Considering the most profitable markets in which Samsung compete, it is important highlight how the company has been able to enrich their internal innovation capabilities, with an increasing number of partners that fostered an competitive behavior by the firm. Nevertheless, internally the firm has distinguished three layers for R&D and knowledge management employed in different hierarchical levels: the Samsung Advanced Institute of Technology (SAIT), the R&D centers and the Division development teams.

**Figure 43:** Internal R&D organisation

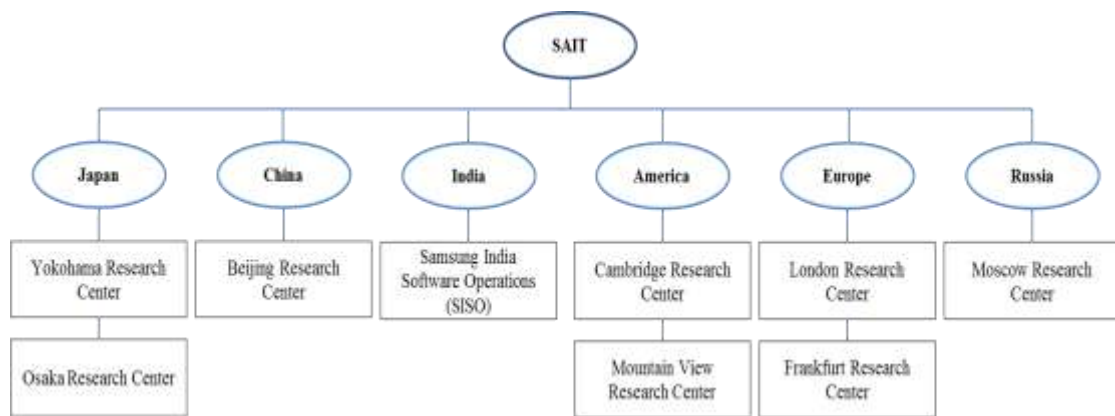


Source: based on 2015 Samsung Electronics Sustainability Report.



Each layer has different tasks. At the highest level, SAIT is focused on development of emerging technologies that may materialize over a long term. SAIT is a heritage from the Samsung Group, established in 1987 and acquired by Samsung Electronics in 2008. It is the most uncertain level of planning in technology route and it works with the goal to identify continuous future growth opportunity. This institute isn't closed in corporate headquarters but is managed under a global research approach. SAIT is located in 6 countries, as shown in figure 44.

**Figure 44:** SAIT geographical distribution



*Source:* based on Samsung Electronics institutional website, consulted on June 14<sup>th</sup> 2016.

SAIT is focused on three main research domains such as future IT, advanced devices and new materials, that are the next developments for future strategy.

The second layer is built upon the R&D centers, employed in the development of those core technologies that will be applied to the next generation of products and services. R&D centers are organised into three main categories:

- digital media communication (DMC): 24 centers in 15 countries aimed to foster product changes in information technology, mobile communication and consumer electronics.
- software: 11 global centers specialised on software development because R&D expenditure shifted from hardware (tangible) to software (intangible) disposition. The main objectives are security solution, big data and cloud computing.

- semiconductors: 14 centers in 7 countries with the goal to maintain the corporate leadership in semiconductor markets. These poles are well tied with universities that helping Samsung in basic research and development.

**Table 36:** List of main Samsung’s R&D Center

<b>R&amp;D Center</b>	<b>R&amp;D Areas</b>
<i>Samsung Information Systems America, Inc. (SISA)</i>	Strategic parts and components, core technologies
<i>Dallas Telecom Laboratory (DTL)</i>	Technologies and products for next-generation telecommunications systems
<i>Samsung Electronics Research Institute (SERI)</i>	Mobile phones and digital TV software
<i>Moscow Samsung Research Center (SRC)</i>	Optics, software algorithms and other new technologies
<i>Samsung R&amp;D Institute India - Bangalore (SRIB)</i>	System software for digital products, protocols for wired/wireless networks and handsets
<i>Samsung Telecom Research Israel (STRI)</i>	Hebrew software for mobile phones
<i>Beijing Samsung Telecommunication (BST)</i>	Mobile telecommunications standardization and commercialization for China
<i>Samsung Semiconductor China R&amp;D (SSCR)</i>	Semiconductor packages and solutions
<i>Samsung Electronics (China)R&amp;D Center (SCRC)</i>	Software, digital TVs and MP3 players for China
<i>Samsung Yokohama Research Institute</i>	Core next-generation parts and components, digital technologies
<i>Samsung Poland R&amp;D Center (SPRC)</i>	STB SW Platform Dev., EU STB/DTV commercialization
<i>Samsung R&amp;D Institute India - Delhi (SRID)</i>	S/W Platform and Application Design, Graphic design

*Source:* based on 2014 Samsung Electronics Annual Report.

Finally, at the basic level of the pyramid, there are the Division Product Development Teams focused to the product development inside each business division. Samsung has provided each one of the 9 business division with a development team responsible for the technological choice about the single products.

Company support the present hierarchy under its R&D efforts with the aim of two top entities as the Global Technology Center and the Corporate Business Innovation Team, that are committed in achieving the optimisation for production

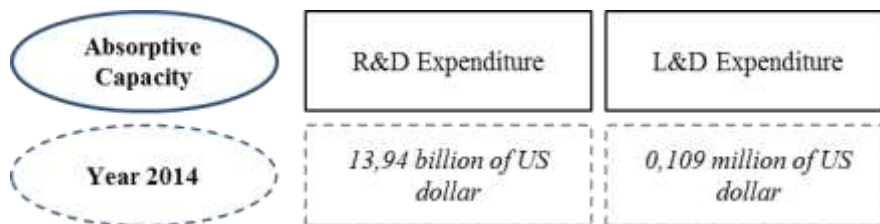
standardisation and core component internal appropriation. These two entities are control towers able to gain synergies and improve quality in the implementation of technologies at the manufacturing level.

Chapter one discusses the importance to improve internal skills, guaranteeing the absorptive capacity, useful to enhance the acquisition from external source of innovation. Samsung confirmed this assumption showing the complementary effect between internal and external knowledge. According to Cohen and Levinthal (1989) absorptive capacity is generated by R&D expenditure and professional training for firm’s employees. Samsung Electronics provide to its employees a systemic learning and development system (L&D) based on three degrees of expertise development process:

- core: training on corporate culture, through values and vision;
- leadership: training on the development of leadership skills;
- expertise: training on specific skills built on the business processes.

Commitment in internal development of skills are particularly tied to innovation in the third degree of corporate education and it is generally accounted by the Sustainability Report with an amount of 27.431 courses addressed to 3,48 million of trainees in South Korean and overseas.

**Figure 45:** Samsung expenditures on absorptive capacity



Source: 2015 Samsung Electronics Sustainability Report.

Beyond the training pillar represented by L&D for the personnel, another important stimulus to the growth in absorptive capacity is the remuneration system for innovative and talented employees. If absorptive capacity has a cumulative expression as stated by various authors, Samsung succeeded in the improvement of

their components. At the basis of these behavior there is the awareness that R&D cannot be outsourced searching for a substitution effect.

### **6.3 Openness in Samsung's Networking**

According to a connect and develop economy (Huston & Sakkab, 2006) a firm alone is not sufficient to reach high performance in the most innovative markets. As a result in the previous chapters there is the literature review about corporate network and Open Innovation that permit to highlights several characteristics who a firm may possess for enrich its own knowledge base. Present chapter is focused on the test of the previous theoretical findings with the comparison with a successful large company as Samsung Electronics.

Analysis will be managed with two levels of examination:

- the presence of openness in the focal firm;
- the disposition of eventual relationships from the focal firm to external source of innovation.

#### **6.3.1 Samsung's propensity to openness**

As a result from the discussion in chapter one there are three features useful to investigate about a firm's openness, and these are the same showed by Market-driven management literature:

- culture;
- capabilities;
- organizational configuration.

Samsung Electronics is managing all these features in an open perspective because expressed in various elements an overcoming of the closed innovation model. In fact, both in the official annual reports and in the institutional communication (website, press news, investor relators report,...) Samsung reserves part of its accountability with sections named 'Open innovation' and it heavily invest in its implementation with the creation of *ad hoc* organizational structures.

According to the methodology used by Chiaroni et al. (2011) or by Huston and Sakkab (2006) the analysis of corporate initiatives in the Open Innovation implementation may be suitable to explain if and how a company has an open orientation in its business model.

Samsung Electronics started many initiatives that brought to a more porous boundaries of the innovation process. The most interesting institutional programs are the following:

- 2013 Global Innovation Center: a set of poles placed in New York, San Francisco, Silicon Valley and Suwon (South Korea). GIC has the goal to encourage and adopt outside-in process, because it seek new idea, services and technologies in the external environment and put the best of them inside internal R&D process.

- 2009 Global Research Outreach (GRO): a program who involves the best prestigious university (100 leading university worldwide) with the aim to reach the best emergent ideas and acquire them. Initiative is organized as a tournament with annual call for ideas and specific timeline in several research domain (Figure 46). Applicant for the GRO must be academic researchers or professors.

**Figure 46:** Global research outreach: research themes

AR/VR • IoT • Next Generation Computing • Machine Learning & Recognition • Natural Language Processing • Neural Processor • Artificial Intelligence • Autonomous Driving • Software Engineering • Robotics for Human Augmentation • Security & Privacy • Data Analytics • Sensor Technology • 5G Mobile Applications • System Arch. for Storage & Memory • 2D Materials/Devices • Next Gen. Sensors & Detectors • Energy Harvesting • Inorganic Photonic Materials • Functional Material • Organic Materials • Microbial Conversion Materials • Nano Structuring • Material Informatics
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*Source:* based on 2016 SAMSUNG Global Research Outreach.

Contest winners will benefit from a financial support up to 100.000 USD per year, renewable three times, after an advancement evaluation.

- Collaborative Research Expert Open (CORE): an initiative that involves about 40 experts aiming to establish a network where they may exchange ideas and suggestions. CORE works as a professional crowdsourcing platform in which multidisciplinary collaboration acts as a key of overcoming for technological challenges. Members are called to identify and follow eventual new business and technological opportunities acting as an outpost in the uncertain land of technological

evolution. Because the mission of the present initiative CORE accepts in its membership high skilled professionals interested in long-term relationships.

Summarizing the initiatives outcomes and objectives allows to reconsider the real option approach (see chapter three) in a practical and applicative way pursued by Samsung Electronics. It perceives the risks of obsolescence and time-based competition on technology and prefers to keep an wide scissor of alternatives (as options) for future business opportunity. Moreover Samsung adopts a open solution in which the environment suggests to the company which new technologies may be the future firm's strategy, and this permits an approximation with what Market-driven management literature suggests.

### **6.3.2 Samsung's Sources of Innovation**

Previous paragraph focuses on how openness is implemented at a corporate level through initiatives, projects and internal R&D setting. Now it is important to identify which external sources of innovation are involved in the process and how them cooperate with Samsung enhancing its performance. Chapter four listed, in a theoretical perspective, several external sources considered as pillars in the Open Innovation literature, and they are observed in the following sections.

#### **6.3.2.1 Universities and Research Centers**

Beyond the GRO initiative Samsung has a strong tie with domestic and foreign universities and research centers. The powerful of investments provided by the South Korean government to academic realm in engineering and hi-tech scientific domains has pushed the local *chaebols* to collaborate with the research institutes. Company invested in partnerships with universities with a twofold goal:

- strengthen the Samsung's knowledge base;
- improve the relationship with local communities under a sustainability approach.

Following the main principle of win-win approach, in which all parts involved in an agreement mutually benefited from the others avoiding each opportunistic

behavior, Samsung established a network of partnerships witnessed by the corporate sustainability report (2015) who see in the following cases several successful examples of Open Innovation practices.

In Vietnam was founded the Samsung Talent Program (STP) in partnership with Hanoi University of Science and Technology since 2012 with the aim to support the best scholars. They are trained in Samsung Labs about computer programming courses in Java and the best of them are recruited for an internship in corporate R&D centers with the task to develop software addressed to Southeast Asian countries. Company positively assessed the scholar contribution to innovation and expanded the STP to over 420 university students, with a fund of 192.000 USD by 2016.

STP aims to involve high skilled scholars as a way to support the development of application and IT solution but other initiatives are directed to favor the internalization of new ideas from university students. An example is the contest organized in cooperation with 11 Singapore's University in which scholars proposed IT solution to social problems. Universities are supported by company's employees and experts in IT technology because a major coherence between the corporate needs and the scholars proposals. This examples combined with the University-Industry Cooperation R&D Center established in Turkey shows how the company consider the academic realm as ideas and development partner, usually with an increasing interest toward local peculiarities.

**Table 37:** Samsung university-industry main goals

<b>CULTIVATING THE FUTURE</b>
<i>Our strategic alliances between industry leaders and top universities, both domestic and international, lay the foundation for visionary researchers and our robust network of next-generation technologies.</i>

*Source:* based on Samsung Electronics Website, consulted on June 15<sup>th</sup> 2016.

As a result university-industry strategic relationship may be started thanks both to independent research and in sponsored training, and always with the aim to improve the technological position. The company itself explains that universities are one of the strongest pillars useful to reach Open Innovation.

Under the real option approach Samsung confirmed that investments in different university-industry cooperation are a way to ensure the newest ideas and technologies. At the same time such cooperation is useful to ensure an employees turnover because best talents are recruited with a gradual integration. Finally Samsung planned a future empowerment of research openness because a stronger collaboration with academia about cross-education and long term research plans. As a counterparts of this future project the company identifies universities as Stanford, Georgia Tech and Carnegie Mellon University about research fields as algorithm and system architecture beyond the more traditional memory, packaging, power sources and software (Samsung website, 2016)

Finally, it is clear that universities are a Samsung's external source of innovation because they are crucially in the past experience and are currently considered at the basis of the company's future strategy of Open innovation.

In public policies (see chapter four) considerations, Samsung like a *chaebol*, benefited from externalities originated by South Korean wide investments on R&D, with special regards about electronics and engineering.

### **6.3.2.2 Customer Empowerment and Open Source**

Being a global network, the company headquartered in Seoul own a strong commitment in the relationship with its customers thanks to communities and customer engagement. Moreover it has been able to implement an active involvement of people interested to enhance the product and service innovation. There are three degrees of interest in this set of relationships:

- community of users;
- crowdsourcing initiatives;
- open source platforms.

#### *Community of users:*

In many countries Samsung created a community of users linked to the institutional website and based on the local languages. The first message communicated by the community is “share your experience” as a summary of the company's purpose to



create a sense of belonging and a place where all its own customer may discuss or suggest something new.

Community is organized as a forum in which people proposes a question and others members answer. By reclaims and warnings by large array of users Samsung chose which products need and improvement. This is an example of traditional innovation by interaction with customers, especially those users that are pro-active (Gnecchi & Corniani, 2003).

#### *Crowdsourcing:*

Crowdsourcing is a way to consider external ideas originated by users, individual or communities, who invest time and resources for resolve the firm's issues. More and more companies are interested in people that offer its knowledge in various forms such as engineering, technical solutions, ideas and design. Samsung nurtures several crowdsourcing initiatives as a part of its open innovation strategy and because in time-based competition no firm can exclude the important knowledge flows caused by a larger community of solvers.

Despite the corporate dimension, Samsung sometimes chose to submit its technical issues to the solvers communities through the help provided by intermediation. In particular it involved two important platforms recognized for their credit in open innovation and these are Ninesigma and Innocentive. The choice to do not use a full internal control crowdsourcing initiative can be addressed to the lack of a well-developed community of solvers or to the acknowledgment for better and faster functioning from experienced specialist.

Nevertheless one of the larger crowdsourcing task was the launch of an innovation tournament for the OLED display (Ninesigma, 2013). Organic light emitting diode is a technology where Samsung praise a undisputed leadership (98% in 2013) but at the same time it opened its advanced technical problems to Ninesigma's community with the goal to improve the product performance.

Samsung Display Gallery accelerates the development of game-changing products through continuous interaction with a high skilled technical communities. Through this platform, Samsung seeks solutions to a variety of needs like enhanced backlight systems for LCD displays, flexible display materials, and way to encapsulate flexible

OLEDs. Firm will benefit from the outside-in flows of knowledge that solvers provide while Ninesigma has the likelihood to improve the quality and density of its own community.

*Open source:*

In electronics markets many firms established platforms aimed to implement the open source. Samsung is not an exception thanks to a proprietary platform called Open Source Release Center (OSRC) hosted by a website, external to the main institutional corporate's one. OSRC offer through a simple intermediation platform the possibility to download many source codes in order to improve them for the best customer's satisfaction.

Previously it selected the product in which open source is available, and this highlights how Samsung pursues a hybrid strategy where not all codes and not the totality of each single code are revealed.

In particular there are five areas of interest such as:

- TV and video;
- mobile;
- photography;
- office;
- business.

They are further divided in 14 product ranges. Once selected the products in which try an improvement, people can download the part of code.

Later developers find a table in which are reported model, version, source code and a box where they may suggest or request something about the codes.

Even though Samsung is not a pioneer in open source and show a hybrid strategy, it is one of the top contributors for Linux kernel, probably because Android is pivotal for mobile performance.

### **6.3.2.3 Competitors as Sources of Innovation**

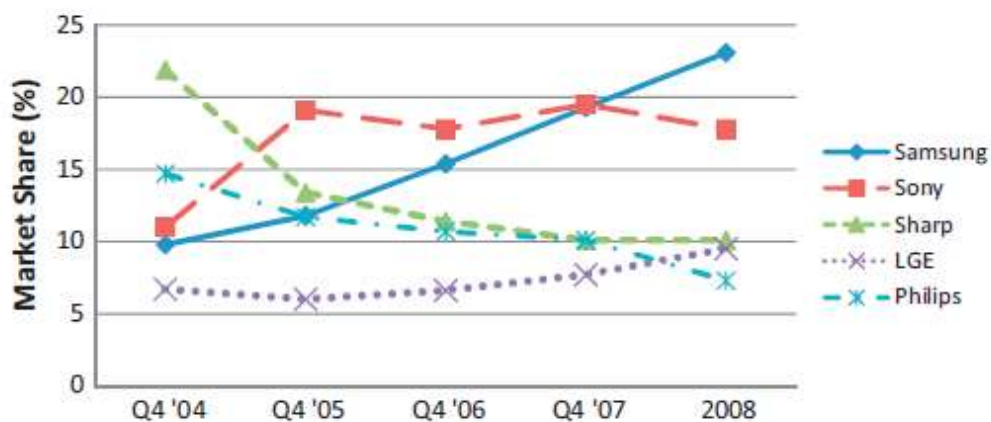
Samsung Electronics has experience with many strategic alliances with a large array of different organizations. Beyond suppliers, distributors and manufacturing

partners, the Korean giant has implemented a system of relationships among several source for R&D laboratories. Nevertheless among them there are few competitive alliances.

Chapter four face the Android example as a point of contact among electronics players, not necessary intended as competitors. Instead, in this section is more appropriated the S-LCD case where the external source of innovation is mainly a single competitor.

During the last decades there was a strong competition between two large electronics corporation: Samsung electronics and Sony. After the converging phase in TV industries these firms chose to collaborate for the a new technology standard: the LCD. Samsung had aimed to a structural change in its production capacity, searching for superior economy of scale. Instead, Sony had to recover its early position in TV industry, lost in 2003 as a result of a not-completed understanding of the new technologies. On April 2004, they established an equity joint venture, called S-LCD, by investing each one, a billion of US dollars. Few years later the coepetition was revealed a success, with the definition of the LCD standards. In 2008 Samsung reached the market leadership, showing strong capabilities to capture value from innovation. Sony succeed to become the second firm on the market, and competition pattern was heavily revolutionized. Sharp, previous leader, was limited to split the remaining 27% of the market with its competitor Philips and LG.

**Figure 47:** Market share trend in TV Industry



Source: Co-opetition between giants: collaboration with competitors for technological innovation (Gnyawali & Park, 2011).

Co-opetition involved the standard change from CRT TV to LCD, with an innovation that conditioned the competitive arena and the technologies useful for firms. No firms could be sustain the costs of the new technology with a stand-alone strategy and moreover Samsung and Sony reached a tangible profit result by coepetitive innovation.

Furthermore the entire dynamics of TV industry was transformed in a network-to-network coepetition with a strong concentration in few powerful poles, as showed in table 38.

**Table 38:** Co-opetitive Networks in TV industry

<b>Network</b>	<b>Membership</b>
<i>S-LCD</i>	Samsung Electronics, Sony.
<i>LG Display</i>	LG Electronics, Philips.
<i>IPS Alpha</i>	Hitachi, Panasonic, Toshiba.
<i>Sharp Display Products Corp</i>	Sony, Sharp, Toshiba, Pioneer.

*Source:* based on Co-opetition between giants: collaboration with competitors for technological innovation (Gnyawali & Park, 2011).

Samsung achieved a big result by its coepetitive efforts because a strong internal capability to learn and cooperate with other firms developed in many years of innovation attitude (Gnyawali & Park, 2011).

Coepetition is a profitable way for reach innovation an open way, because it use external ideas, competences and technology, and integrates it with internal ones. Thus this strategy is well fitted with Open innovation literature as much as with other research streams. Anecdotal evidences and literature suggested that it is also an efficient strategy for trying to innovate in high-tech industries, but with a strategic attention to the appropriability issue.

#### 6.3.2.4 Start-Up and SMEs

Samsung own a large array of smaller firms inside its network but they are mainly part of the company's funded perimeter. However company manages several relationships with start-up and small and medium enterprises. In particular with the establishment of a new Open Innovation center in 2013 placed in Silicon Valley, Samsung is aiming to reach two different goals:

- provide a financial support to the best start-up in order to easier the complex and thorny phase of the business start;
- provide a knowledge support to the best start-up in order to help the technological transfer toward Samsung and its partners.

The first goal is sustained by two corporate divisions such as an accelerator and a venture-capital wing. Start-ups are suffering about the initial investment and large firms that would cooperate with them have to be patient and provide financial aid. Under a theoretical approach it is coherent with the Real Option Theory because large firms avoid technological obsolescence and speed-up their technological domains investing in external options that are internalized only if they are coherent with company's business model. Start-up and SMEs, together with universities and research centers seems to be the right partner for achieve this objective. Flexibility and pro-activeness in new opportunities is a clear characteristics of smaller firms while their larger counterparts have usually an intrinsic rigidity given the corporate size and procedures. Moreover it is unthinkable that a unique firm, also the larger innovators, may be always the pioneer in all technological domains, specially under a convergence setting. According with the principle "not all the smart people work for us" quoted by the Oracle CEO, firms are obliged to enlarge their technological base with knowledge from external sources. Start-up and SMEs on the other hand are tied to littler knowledge base but more specific in few domains. A set of relationships among these organizations are useful because the complementarity of knowledge and features of the involved companies. Considering the time of engagement it is possible to distinguish two different approaches. When the large firms previously invest in the start-up then there is the precondition to an option creation. Later if the start-up output is coherent with large firm's business model there is the acquisition of

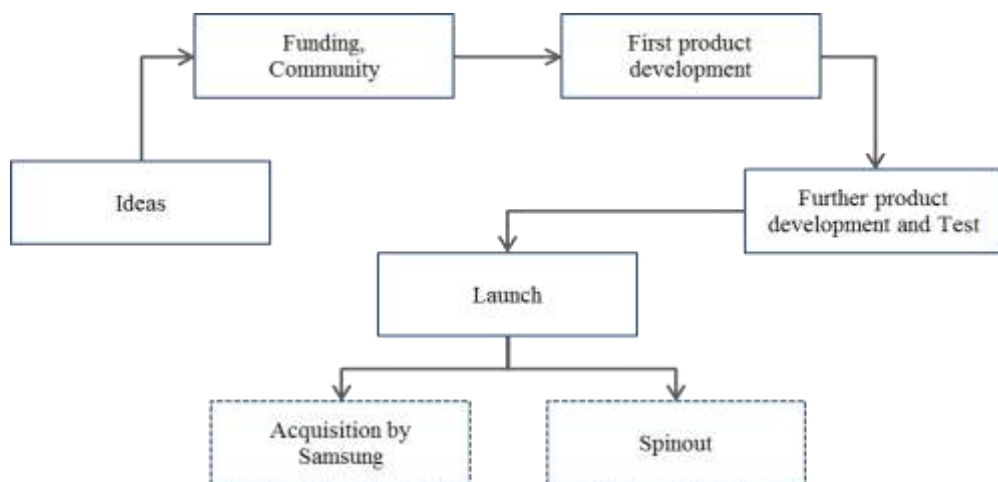
the linked knowledge or, on the contrary, the output may be sold on the technology market (von Zedtwitz & Gassman, 2002).

The Samsung case with the previous establishment of dedicated processes and structures seems to be more similar to real option approach. In fact the company early invests in a network of smaller firms providing a technical and financial support.

This example permit to consider the issue represented by the role of intermediation. Through the analysis of secondary data as business overview, sustainability and financial reports and institutional communication there aren't mentions about innomediation. Samsung manages autonomously the processes of Open Innovation thanks to a set of structures created with this specific purpose. Company benefited by the full control of the relationships with smaller partners in an reverse way in comparison with crowdsourcing initiatives where the aim provided by high-skilled external platforms is considered irreplaceable. In fact Samsung Accelerator, a specific division of the Samsung Global Innovation Center, is built under the Market-driven management approach to support innovation by external sources.

In particular, Samsung Accelerator permits to reconsider the stage-gate model mixed to real option. Figure 48 shows a process developed in six step of assessment from the start-up to the output (Samsung accelerator, 2016).

**Figure 48:** New product development process in Samsung Accelerator



Source: based on Samsung accelerators website, consulted on June 20<sup>th</sup> 2016.

The final dichotomy represents a solid point of contact with the real option theory where options exercised that are coherent with company's business model are internalised while the not coherent but valid ones are differently developed.

Also the Samsung Accelerator recognize the value offered by a cultural adoption of the Open innovation principles that are expressed thanks to three main driver such as:

- events;
- community;
- spaces (intended as creative and collaborative environments).

This part of Samsung Global Innovation Center suits with the role of innomediators and carry out many tasks of that figure. However the paradox of disclosure issue remain unsolved even if in this case Samsung also act as financier and hence it is reduced the opportunistic behavior likelihood.

Finally summarising the Samsung case it is clear a strong approach to Open innovation at a corporate level both at a cultural and an organizational aspects. Openness is empowered with a set of relationships with all the sources previously identified by literature such as: universities and research centers, users and communities, competitors and start-up and SMEs. Each source provide to Samsung different knowledge contribution but all of them are managed with a long-term approach and strong communication efforts.

The case completed the theoretical basis of the thesis showing several corporate initiatives aimed to adopt a successful Open Innovation strategy. Samsung is a great example because the breadth and depth of the sources of innovation is well reported by institutional and formal communication. Moreover a larger part of studies on the Chesbrough's model is focused on north American companies whereas there are many innovative firms from Asian countries.

## Chapter 7

# Conclusions

### 7.1 Findings and Final Remarks

This thesis discusses the adoption of Open Innovation by global networks who play in high degree of competition, and in particular in the modern electronics scenario. The first chapters study how the openness is embraced by firms oriented to a market-driven approach in innovation. In particular it splits the openness in four main type of processes such as: sourcing, acquiring, selling and revealing. Because the objective of the research is the paradigm adoption by large *chaebols*, a further analysis is made on the network literature with the aim to bridge the gap between these two research streams. As a result the thesis argues that Open Innovation is a business model who permit a strong mitigation effect on many risks tied to the innovation process. In particular it focus on:

- the reduction of the time lag about new product development;
- a better management about the technological complexity tied to the proliferation driven by convergence of several scientific domains merged in a unique hybrid product;
- to diversify the knowledge sourcing, abandoning the technology roadmap in favor of market-driven orientations;

Openness encourage the sourcing toward several sources of knowledge and according to literature they are deepened in the thesis under the following main sources:

- public institutions;
- users;
- small and medium enterprises and the start-up ecosystem;
- universities and research centers;
- other large firms and competitors.



These sources are the backbone of a network who manage the Open Innovation business model.

The literature review (since 2003) shows a strong academic commitment, both qualitative and quantitative, about the opening of the corporate boundaries during the innovation process. In particular the most important results emerged in electronics and pharmaceutical industry, even if with a quite different functioning. In fact electronics markets permitted to study also the revealing process, under the Open Source Software perspective. As a complement chapter five analyses the barriers to openness and networking, with a particular attention to the Not Invented Here syndrome.

Finally the last chapter is focused on a case study about Samsung Electronics. This company is an innovative south Korean *chaebol* that in the last decades widely invested in reaching the top positions in different electronics market. As a result of the study is showed that Samsung develops many relationships with each source previously defined, and in an active and open approach.

Hence, Samsung adopted some years ago an open business model in its network management, modifying the internal R&D structure in function of universities, research centers, customers, open source users, competitors and start-ups. It is widely coherent with the theoretical background of Open Innovation in electronics. In the previous chapter was replicated the methodology previously used by Chiaroni et al. about the adoption of the Chesbrough's paradigm in a large firm. In fact Samsung has been active in many programs and initiatives tied to the diffusion of the open culture inside its boundaries. Starting from the premises suggested by Chiaroni et al. (2009) and summarizing with what discussed in chapter six, Samsung is a firm well-suited to the institutionalizing phase. In fact, company shows several degree of engagement about OI initiative. Samsung named part of its accountability with the label of Open Innovation and has a large array of ad hoc organizational structures. Since the beginning of the century, few years later that Chesbrough coined the term, Samsung started to invest in projects aimed to support the outside-in processes about several scientific domains (e.g. mobile applications, artificial intelligence, autonomous driving,...). In 2013 the Korean *chaebol* established the Open

Innovation Center in Silicon Valley, and it shows the clear purpose to don't hide the paradigm adoption.

Once clarified the sure subscription of an open business model, other confirmations about collateral research streams are observed.

Absorptive capacity is one of the nearer stream to the acquisition of external knowledge and it suggests that OI is not similar to outsourcing because the difference between substitution and complementary effect. Cohen and Levinthal (1989) and the following literature argued that increasing the absorptive capacity, through expenditure in employees training and R&D expenditure, can foster the knowledge acquisition by external sources of innovation. In chapter six, later an examination of the firm official reports, it was argued the Samsung willingness to increase its absorptive capacity, for example with a strong investments in L&D.

In term of Real options the analysis was more difficult as a result of a scarce documentation about that part of the innovation process and the lack of literature who merge ROT and OI. However in new product development adopted by the Samsung Accelerator there are some footprint of ROT. In fact Samsung Accelerator invest in several start-ups active in different scientific domain and for each one proceed with a process of development and evaluation. This process recall the option creation and option exercise steps. At the end of the process Samsung Accelerator choose between the adoption of the technology provided by the start-up or a spinout.

Finally, Samsung was studied for what is argued in chapter four, about the sources of innovation. In this way there is a strong consistence with the literature because the large Korean *chaebol* has a tradition like a cooperator with other sources of innovation.

## **7.2 Limitations and Emerging Issues**

The first limitation is about the methodology, fragmented in two components: literature review and case study. Literature review about Open Innovation was necessary for find the research questions and the background of the thesis. Argumentations about openness, network and innovation was the output originated

by the review, but it may be more punctual and focused. Instead, case study is based only on secondary data provided by official reports and communications. Samsung Electronics supplies a large array of information and documentations in its mother tongue, and it involves wide complications in their clear understanding. Moreover a direct channel of communication with the large *chaebol* surely may be more profitable in term of learning about the implementation of new innovation processes. A further limitation is the disposition of the bibliographical sources, more suitable for the large firms than other scenarios. Even if the object of this thesis is a large network, a better understand of how the other external sources work in this pattern may be useful. For example there is a large amount of publications about university-industry relationships, but many of them are not coherent with the innovation management. Instead for what is related with the user contribution to innovation there is a flourishing literature started by the premise of user innovation.

Once defined Samsung Electronics as an empirical case of OI implementation another wide limitation is the lack of literature build on South Korean *chaebols* and OI. A comparison with other western firms may be misleading because innovation is historically linked to public policies and institutions and this Asian country lived several events who modified the innovation management.

Since Chesbrough coined the paradigm in 2003, a multitude of research streams are generated because the volatility of the topic. Adoption of OI in large networks is only one of the possible investigation about this theme. In fact other dimensions may be studied by the literature, in particular:

- how does SMEs adopt OI?
- what are the outcome of the OI relationships among universities and firms?
- who are the most important employees in the adoption of OI?
- why openness is more developed in some industries and less studied in others?
- how does the corporate governance affect the adoption of OI?

Changeability is the main characteristic in electronics, and the dynamics of convergence and divergence are strong forces that are continuously shaping the competitive arena. As a result many detailed study will be useful to understand the new functioning of an innovation process that is not bound from a closed approach.

### **7.3 Managerial implications**

Following a closed innovation approach involve only two kind of result for a new technology, the success or a failure. In a modern economy based on time-based competition among large and global networks the failure of a R&D project may be synonymous of the loss of years of investments and efforts. Open Innovation allows to mitigate this effect, because a strong diversification in term of knowledge sources but also in the possibility to profit from the market for technology. Openness augments the innovation sustainability but involves high degree of organizational change. The study about successful pioneers suggest the need for a top management commitment in opening up the firm boundaries. Also, a list of organizational figures as the idea scout and connectors shows the importance of new professional skills and roles. The curvilinear relationship between number of sources and performance recommend a quiet approach to openness while the competitive pressure may suggest the contrary.

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