DOCTORAL THESIS

Title	**Open Innovation Intermediaries: Marketplaces For Innovation**
Presented by	TUBA YESIM BAKICI
Centre	ESADE BUSINESS SCHOOL
Research Unit	INNOVATION AND KNOWLEDGE MANAGEMENT
Department	DEPARTMENT OF INFORMATION SYSTEMS
Directed by	JONATHAN WAREHAM, ESTEVE ALMIRALL

ACKNOWLEDGEMENTS

Writing this PhD thesis was only possible with the support of several individuals. First of all, I would like to express my deepest gratitude to my advisors, Jonathan Wareham and Esteve Almirall. This thesis is a result of their constant support and guidance. I would also like to extend my thanks to the ESADE PhD program, and particularly, Nuria Agell, Pilar Gallego, and Olga Linares, who were extremely supportive during my PhD studies in ESADE. I wish to thank all the company representatives for their valuable input. I would also like to extend my thanks to Henry Chesbrough and Wim Vanhaverbeke. Last, but not least, I wish to express my immense gratitude to my parents for their constant support and patience. Without them, my PhD endeavor would not have been possible. This research has been partially supported by the Open Cities Project.

ABSTRACT

Open innovation offers a novel means of sourcing innovation for companies and cities by opening their boundaries and globalizing the sourcing of innovation. Open innovation intermediaries support and facilitate the collaborative arrangements of open innovation. These intermediaries are both markets for innovation and a source of innovative solutions. The proliferation of on-line open innovation intermediaries – e.g., Innocentive, Yet2.com, Atizo, NineSigma – that link companies and individuals to facilitate open innovation is increasingly gaining attention in the literature.

Open innovation as a field of research is young, and the literature in this area has shown that a variety of companies have successfully emerged to facilitate trade in intellectual property (e.g., ideas, technologies, and patents) through platforms. Much attention has been devoted to the role of these intermediaries in online platforms with single case studies. However, more knowledge and understanding is needed about how open innovation intermediaries function in online platforms and public innovation ecosystems, and, especially why people participate.

This thesis aims to develop and extend existing theory on open innovation with an emphasis on open innovation intermediaries and their underlying mechanisms, supportive motives, and ultimately their presence and role in the public innovation ecosystem. Drawing upon data from empirical findings and several case studies, this dissertation suggests that innovation intermediaries play an imperative role in innovation processes in both public and private sectors. The findings also motivate managers and policy makers with insights to help enhance the innovativeness and competitiveness of their organizations and cities.

PUBLICATIONS

This work encompasses the following publications or conference presentations.

- Bakici, T. (2010) “Quilts of Denmark: Managing open innovation in a low-tech SME”, **European Case Clearing House** (**ECCH)**. (with Vanhaverbeke, V.)

- Bakici, T. (2011) “The Underlying Mechanisms of Open Innovation Intermediaries”, **Service Innovation Yearbook 2010-2011**, European Commission, Information Society and Media Directorate-General (with Almirall, E., Wareham, J.)

- Bakici, T. (2011) “Open Innovation and Public Policy in Europe”, A research report commissioned by **Science & Business Innovation Board**. (with Chesbrough, H. Vanhaverbeke, V., Lopez, H.)

- Bakici, T. (2012) “A Smart City Initiative: The case of Barcelona” 2012, **Journal of the Knowledge Economy**, 1-14.

- Bakici, T. (2012) “Motives for Participation in On-line Open Innovation Platforms” (with Almirall, E., Wareham, J.) **Danish Research Unit for Industrial Dynamics** (**DRUID) Working Paper** no. 11-14, ISBN: 978-87-7873-325-2.

- Bakici, T. (forthcoming) “The Role of Public Open Innovation Intermediaries in Local Governments and the Public Sector” **Technology Analysis and Strategic Management**. (with Almirall, E., Wareham, J.) **2011 Impact Factor: 0.701**

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Chapter 1: Introduction

1.1 Introduction

To be successful in a more globalised and competitive environment, companies and societies need to grow and this can only be ensured by remaining innovative. As today's business environment does not enable companies to produce and manage ideas autonomously, there has recently been a significant increase in the development of innovation practices for cooperating with customers, suppliers, and third parties. A large number of companies have expressed a strategic aim to open their innovation processes through experimenting with different mechanisms to facilitate this transaction. This new approach is identified as open innovation. Open innovation enables companies and societies to remain competitive by opening the knowledge and search space beyond their boundaries to external sources for innovative solutions. Thus, innovation performance is enhanced through cultivating and

internalizing value from opportunities external to the firm, as well as the skilful deployment of internal discoveries to external deployments (Chesbrough, 2003).

A vast transition to open innovation is observed in the private sector, where competition is increasingly becoming established at the level of the ecosystem. This transition is similar to the process in the public sector. Local governments began to address open innovation in response to the growing importance of networks and increasing competitiveness (Parkinson et al., 2004). Public authorities are evolving from being mere service providers to platform managers while collaborating with third parties and citizens. This is seen in European projects such as the 'Open Cities' and 'FIREBALL - Future Internet Research and Experimentation' that are ultimately about bringing open innovation to the agenda of city governance.

To access this external sourcing space, firms and public authorities need to connect with actors beyond their existing networks. However, it is problematic to select, connect, and engage the best solution among the vast number of possibilities that exist globally. This problem can be solved by using open innovation intermediaries, a broker who enables organizations to access external sources. Open innovation intermediaries provide awareness of the needs of seekers, the offers of solvers, and act as matchmakers. It is therefore legitimate to examine the existence of intermediaries in the public sector and analyze their role in the innovation ecosystem of local governments (Chapter 2).

The use of open innovation intermediaries to create new ideas and/or solve internal problems has vastly increased in the private sector as well. However, in this context these intermediaries appear as internet-based technological platforms that act between organizations and online communities. Thus it is initially important to establish the main types of online innovation intermediary mechanisms and analyze which specific processes support them. To further generate managerial implications, it is also important to analyze the underlying tensions and limitations of these mechanisms (Chapter 3).

Like any other online community, online innovation intermediaries are faced with the challenge of attracting people willing to participate in the community. In this area, motives have an effect on behavior that is as important as personal beliefs and social norms.

Therefore, it is important to establish the underlying reasons why people participate in online innovation intermediaries (Chapter 4).

In the search for a better understanding, this study first looks to innovation intermediaries in the public sector, then further analyses online innovation intermediaries in the private sector based on mechanisms and their underlying factors and motives.

1.1.1 Theoretical background

In the following section, an overview of the theoretical background is presented to establish the foundations for the following chapters. Firstly, the importance of innovation is briefly justified, followed by an extensive review of open innovation and open innovation intermediaries.

Why innovation?

Due to the increasing competitiveness of markets, globalization, increasing production costs, and price sensitiveness by customers, companies are forced to innovate through introducing new products or services. Innovation enables the exploitation of new opportunities while lowering costs. Innovation is a broad term that can be categorized into technology, services, processes, and organizations. In brief, innovation can be seen as the creation of new combinations such as new products, new services, and new methods of production/supply to either create or redefine firms and existing markets (Schumpeter, 1934, 1942). Innovation is 'the first commercialization of the idea' and for this reason innovation mostly occurs in commercial sphere (Fagerberg, 2003, p.3).

At a broader level, innovation has become a key to sustainable growth and economic development. Thus its importance is recognized at regional and national levels rather than only at company level (Fagerberg, 2006). This is why most recent research has focused on the importance and economic consequences of innovation, while creating a general consensus that innovation is a main driver of economic progress at company, regional, and national levels. Moreover, as newly commercialized ideas and innovations have economic and social impacts, so national-level policy makers increasingly recognize the value of innovation.

Why open innovation?

Increased competition, shortening of technology life cycles, increased mobility of skilled workers, increased risks, growth of venture capital, and smaller margins encourage companies to collaborate (Chesbrough, 2003). Thus collaboration with external parties, such as buyers, suppliers, and other organizations is important for success in innovation (Faems et al., 2005). This collaboration enables the mobilization of knowledge across organizations (Nonaka & Takeuchi, 1995) and creates more possibilities for combinations, producing yet more innovations with a greater variety of ideas, skills, and resources (Fagerberg, 2005).

Other than the obvious advantages (the creation of new knowledge, ideas, and solutions) open innovation offers other benefits (Hardy et al., 2003). The advantages of open innovation are that human resources, skills, technology, and knowledge are shared and this eventually speeds the innovation process – while reducing the costs of production and diminishing the risk of failure (Tidd et al., 2001; Ring & Van de Ven, 1994).

Eventually, open innovation has changed the approach to innovation management at the regional and national level. Many European cities are now attempting to open their innovation process, while encouraging and supporting companies to do the same.

Closed innovation, also referred to as the traditional model, is a process in which companies develop and market innovations, from basic research to product commercialization, and every step of the process is completed by the company itself. As a result, no information leaks outside company boundaries (Chesbrough, 2003). For most of the twentieth century, this paradigm produced satisfactory results.

In contrast to closed innovation, the open innovation paradigm was introduced by Henry Chesbrough (2003) and implies companies opening their innovation processes for the inflow and outflow of knowledge and information. In 1990s, the process of opening company borders intensified (Gassmann, 2006; Chesbrough, 2003).

Over the last few years, open innovation has become significant for both the practice and theory (Gassmann & Enkel, 2004). Open innovation has also become widely accepted and has become a mainstream research line in innovation literature (Fredberg, Elmquist, & Olilla, 2009). Chesbrough defines open innovation as ‘the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of

innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology.' (Chesbrough, 2006, p.1). Open innovation entails opening the boundaries of the firm to share and exchange knowledge and information, using external knowledge to increase speed and enhance the efficiency and effectiveness of a firm's focal innovation process, and selling internally generated knowledge that is not used in order to increase revenues (Chesbrough, 2004; Gassmann, 2006; West & Gallagher, 2006).

Prior literature has examined, under the label of open innovation, various phenomena: open business models; challenges of open innovation; open sourcing; and specifically, open source software; performance of open innovation; and finally, the transformation and implementation of open innovation. Among these studies some researchers analyzed the motivations of third parties (Von Hippel & Von Krogh, 2006; West & Gallagher, 2006); as well as the motivations of companies for transforming (Chesbrough & Appleyard, 2007; Van der Meer, 2007). Various researchers focused on the impacts of open innovation in terms of performance (Dahlander & Mckelvey, 2005; Fransman, 2008; Lerner & Tirole, 2005) and challenges (Vujovic & Ulhøi, 2008; West & Gallagher, 2006), while others analyzed the antecedents of open innovation (Dahlander & Gann, 2007; Raasch, Herstatt & Lock, 2008; Truffer, 2003). Recently, researchers have broadened their focus into the services sector (Chesbrough, 2011) and SMEs (Van De Vrande et al., 2009). Only a few papers examined the process by which open innovation occurs (Huston & Sakkab, 2006; Kodama, 2005; Van der Meer, 2007). However, most cases are from high-tech industries. For instance, some studies have reported successful stories about the implementation of 'open innovation' or 'open business model' in companies such as Qualcomm Inc., Genzyme Corp, Procter & Gamble Co., Fujitsu, Apple, and IBM (Chesbrough, 2003; Kodama, 2005; Van der Meer, 2007). Moreover, this stream of literature has emphasized the transformation process that companies follow when moving from closed to open innovation.

Why open innovation intermediaries?

Firms may find themselves having to struggling to move from closed to open innovation. There are number of challenges, such as obtaining access to external knowledge/partners

(Omta & Van Rossum, 1999), risk of information leakage (Inkpen & Beamish, 1997; Szulanski, 2000), and lack of trust (Doz & Hamel, 1998). It is therefore crucial to know how to deal with these challenges. Access to external knowledge is a major challenge for organizations and this is why third parties, innovation intermediaries, become involved to facilitate access.

Organizations that act like an agent or broker in any aspect of the innovation process between two or more parties are defined as innovation intermediaries (Howells, 2006). An innovation intermediary is a major source of innovation since the innovation process generally initiates with the generation of new ideas (Harvard Business Essentials, 2003). Research on innovation intermediaries dates back to 1990s, but it has primarily focused on the role of innovation intermediaries and few studies have addressed performance (Howells, 2006; Lichtenthaler & Ernst, 2008).

However, with the rise of open innovation the functions of innovation intermediaries have widened. Today, innovation intermediaries assist other organizations to successfully implement open innovation by offering a platform for intellectual property exchange for ideas, technologies, and products. This is why this study defines these intermediaries as open innovation intermediaries. These intermediaries gather external ideas/solutions and select those that best match the needs of organizations. Thus the era of open innovation has given the rise to intermediaries that play an important role at such stages of the innovation process (Chesbrough et. al., 2006).

The following section emphasizes the literature gap for open innovation intermediaries.

1.1.2 Research gap

Recently, open innovation intermediaries have acquired an increasingly global presence with their novelty, rapid growth, and consequent success (Piller & Diener, 2010). The focus on these intermediaries has increased – especially after the initiative of the American government with *Challenge.gov* to find innovative ideas, products, and processes for the resolution of federal problems. Lately, academia has focused on open innovation (OI) intermediaries.

With the rise of the open innovation concept, innovation intermediaries have received greater attention (Chesbrough, 2006). However, despite the growing literature, there is a limited number of empirical studies (Chesbrough et al., 2006). Some studies have offered a broad view on how open innovation intermediaries function and have explored some aspects of their operations – but mainly with single case studies (Lakhani et al., 2007; Boudreau et al., 2008; Jeppesen et al., 2010).

However, open innovation intermediaries do not employ a unique organizational structure as a result of multiple underlying mechanisms that use various motivations and incentives to increase participation. While innovation intermediaries, mechanism design, and motivation strands have been studied in depth separately, to our knowledge, there has been little linkage among these lines of research. A review of previous research has shown that the mechanism design of open innovation intermediaries has not yet been examined.

Likewise despite extensive analyses of motivations of participants in open source software literature (Crowston et al., 2012), none of the previous research addressed motives for participation in open innovation intermediaries based on a review of previous studies. Thus there is a lack of research that specifically analyses these underlying mechanisms that open innovation intermediaries use and their underlying motives from an empirical perspective.

Furthermore, most of these studies on innovation intermediaries focused on online intermediaries (e.g., Ninesigma, Innocentive) that collaborate within the private sector, rather than intermediary organizations in the public sector. However, the transition in city halls demonstrates the existence of intermediary organizations in the public sector. Thus there is a lack of research exploring the presence of these public sector intermediaries and their role in innovation processes in city halls.

This thesis mainly attempts to answer the following research questions: (1) What are the main roles of innovation intermediaries in public innovation ecosystems? (2) What are the underlying mechanisms of innovation intermediaries? (3) What are the supporting factors and motives for innovation intermediaries to sustain participation? (See Figure 1.1).

Appropriate and complementary research methods are selected to answer each research question. The focus of this thesis is on open innovation intermediaries with analysis at three levels: regional innovation systems (Chapter 2); organizational/intermediaries (Chapter 3);

and individual/members of an online community (Chapter 4). The role of these intermediaries in regional innovation system will be analyzed (see Figure 1.1). Online open innovation intermediaries will then analyzed at an organizational (Chapter 3) and individual level (Chapter 4).

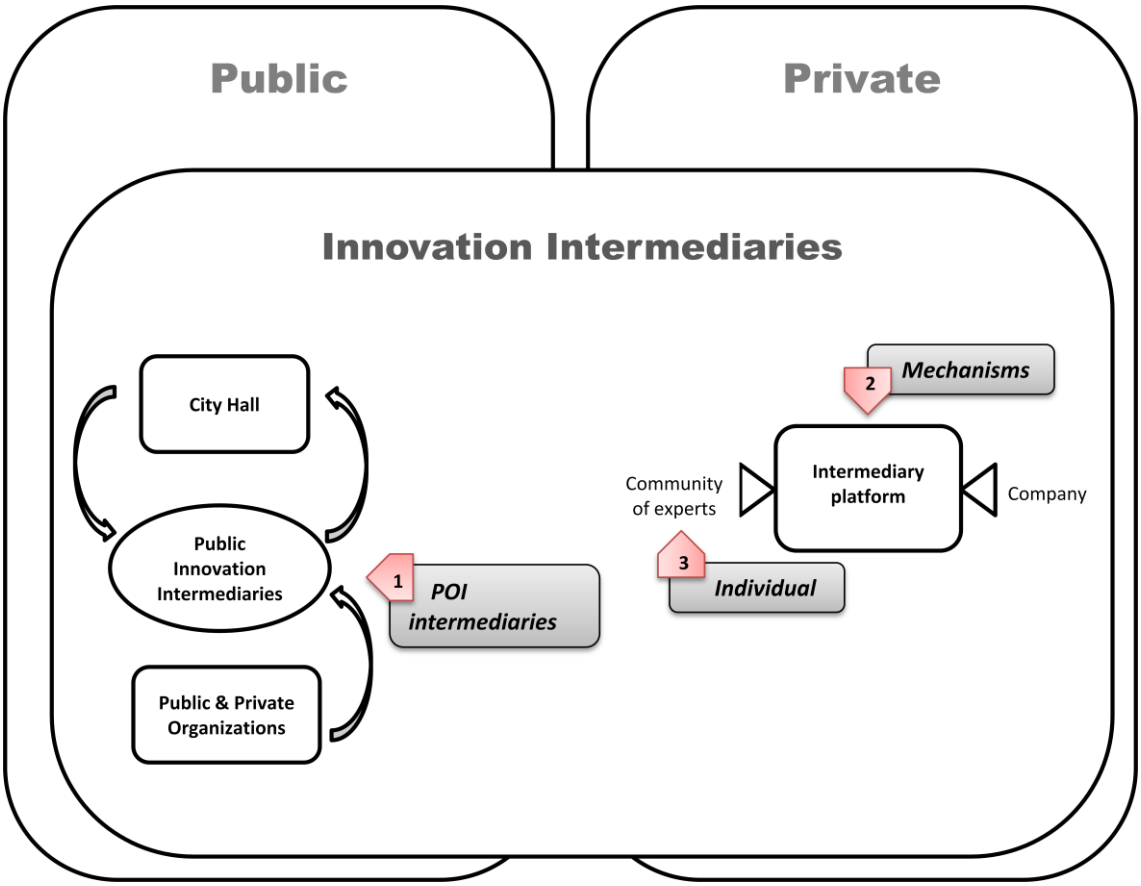

Figure 1.1: Connections between the studies

1.1.3 Objectives and research problem

Organizations have recently become more open in their innovation processes (Chesbrough, 2006). Nevertheless, this requires inclusion of external resources for the innovation process that companies are not used to managing. This requirement creates a need for third parties to support these external resources for the company. In the literature, the implementation

of open innovation within large corporations has been widely examined through case studies (Sakkab, 2002; Chesbrough, 2003), but only a few studies have focused on open innovation intermediaries and to our knowledge none has focused on intermediaries in the public sector. The implementation of open innovation across European cities demonstrates the importance of the issue and creates an opportunity to study these intermediaries.

Due to this practical need and the lack of research on open innovation intermediaries in both the public and private sectors, it is important to understand the working mechanisms within these intermediaries and how it is sustained by various motivations during the open innovation process. Investigating the human side of open innovation intermediaries is relevant for both practice and academia. Hence, the overall objective of this thesis is to explore the underlying mechanisms and motives of online open innovation intermediaries. The thesis also investigates the presence of intermediary organizations and their role in the innovation ecosystems of cities.

Specifically, the research objectives of this thesis are as follows: 1) explore the presence of intermediary organizations and investigate their role in the public sector; 2) explore the implications for policy makers; 3) explore and analyze the innovation process of open innovation intermediaries; 4) cluster the practices of on-line open innovation intermediaries so as to distil their underlying mechanisms; 5) analyze on-line open innovation intermediary mechanisms in depth through algorithmic mechanism design; 6) analyze the main incentives/motives for participation in on-line innovation platforms; 7) explore differences in the motivations of a crowdsourcing platform and an on-line open innovation intermediary and; 8) explore the managerial implications for the choice and use of innovation intermediaries.

1.1.4 Research questions

This thesis addresses open innovation intermediaries with specific research questions for each chapter.

A number of research questions were crafted to explore intermediaries in the public sector. Chapter 2 analyses open innovation intermediaries in public innovation systems by

addressing the following research questions: 1) how do public and private agencies function as POI intermediaries? 2) How do local governments govern these intermediaries and manage the information flow? 3) What are the main benefits and obstacles encountered by both local governments and public intermediaries? 4) What type of policy implications can be derived? Public open innovation (POI) intermediaries refer to public or private organizations that intermediate between city halls and other organizations by providing innovative ideas and solutions to city hall problems.

From the point of view of the underlying mechanisms discussed in Chapter 3, the following research questions are addressed: 1) What are some main archetypes of open innovation intermediary mechanisms? 2) What specific processes are supported by these mechanisms? 3) What are the underlying tensions, pitfalls, and limitations of these mechanisms? 4) What are the managerial implications for the choice and use of open innovation intermediaries? In this and the following chapters 'open innovation intermediaries' are defined as the organizations that use a web portal to intermediate between companies and experts to solve challenges or create new ideas for the innovation process. However, since these intermediaries vary in the forms and services they provide, it is important to find and analyze the main archetypes and their mechanisms.

The research questions addressed in Chapter 4 are: 1) What are the underlying motives behind participation in online open innovation communities? 2) Which factors and motives have a greater impact on the intention to participate? and 3) How can platforms improve their mechanisms in order to attract more participants? In this respect, motives cover both intrinsic and extrinsic; while norms, perceived behavioral control, and attitudes are also assessed. These factors help to delve into the intention of people when participating in online communities of intermediaries.

1.1.5 Contribution of research

The present contribution of this thesis should not be seen as an attempt to dismiss previous work on the subject, but as an attempt to revise and extend it. This study extends the current understanding of open innovation in both public and private sectors by describing

open innovation intermediaries from mechanism and supporting-motive perspectives. Little is known about the specific mechanisms and motives that organizations should pursue and which factors and motives are influential for intention to participate. This is why this study further examines the specific mechanisms practiced by open innovation intermediaries.

This thesis is expected to contribute in several ways to the existing literature by: 1) disclosing distinct mechanism archetypes employed by on-line open innovation intermediaries; 2) revealing some important underlying variables that are generalizable across mechanisms that vary with purpose and expand open innovation, TPB, and intermediary literature; 3) assessing the heterogeneity of participant needs and how to increase user commitment; 4) derive the tensions and limitations of each mechanism (as well as providing managerial implications); 5) provide managerial implications on the use of open innovation intermediaries and improve the design of these platforms; 6) reveal the main motivations and factors that affect the participation of people in on-line open innovation intermediaries; 7) explore which rewards (extrinsic or intrinsic) have more impact on the intention to participate; 8) provide managerial implications for the managers of open innovation intermediaries; 9) explore the existence of open innovation intermediaries in the public sector; 10) provide a framework for the intermediary role in the public sector; and 10) provide implications for policy makers.

The next section presents the research sites and methodology used to uncover open innovation intermediaries.

1.1.6 Research sites and methodologies

To achieve the objectives of this thesis and answer the aforementioned research questions, a variety of data was collected through structured from in-depth interviews, surveys, and secondary sources. Three research studies were conducted between October 2009 and June 2012. Descriptive research was conducted by collecting data from secondary sources (e.g. internet and scientific publications). Descriptive research was used to acquire information about the current status of a phenomenon to portray what exists with regard to conditions in

a situation (Key, 1997). Two projects (Open Cities and FIREBALL – Future Internet Research and Experimentation) and specialized events for these projects provided access to primary sources, such as in-depth interviews and surveys. The main objective of these two projects is to bring innovation, particularly open innovation, to the agenda of city governance. In both projects, online open innovation intermediaries and uncharted public open innovation intermediaries were observed.

Due to the limited available data, the qualitative research method was chosen for the first part of the study (Chapter 2). An exploratory multiple-case study is used for researching public open innovation intermediaries and their role in the public innovation system. The case study method was chosen due the nature of the research and the research questions themselves. Case studies are a preferential method for approaching 'how' and 'why' research questions in a real-life context (Yin, 2003). For triangulation, multiple sources such as in-depth interviews, web pages, and scientific publications were used. The descriptive part of the research aims to describe the current state of European city innovation systems, and the case studies section examines distinctive features of the open innovation implementations. The principal methodological limitation is the impossibility of generalization since the research only describes open innovation practices in Europe. In fact, case study as a research method does not imply generalizability.

The following chapter presents an extensive empirical evaluation of the mechanisms of online innovation intermediaries based on algorithmic mechanism design. Online innovation intermediary markets are economic information systems that facilitate transactions between buyers (companies) and sellers (experts) as in auctions. Rather than designing a mechanism for online open innovation intermediaries that can incentive compatibility and maximize the revenue of companies and experts, Chapter 3 analyses the existing intermediaries. The algorithmic mechanism design builds on the classical mechanism design in microeconomics and is based on the idea of incentive-compatible protocols that has been under development for the past 50 years. The incentive compatible protocols guarantee that it is in every participating agent's best interest to comply with the protocol, and this enables the achievement of global system-wide objectives. This paper tests various mechanisms of online open innovation intermediaries based on algorithmic mechanism design theory. The main

limitation of this method is the fact that there is a group of problems that are algorithmically approximable but have no reasonable feasible incentive-compatible approximation.

Since online innovation community platforms exploit open innovation by providing companies a platform with which to access a loosely-knit community of innovators, it is crucial to identify antecedents of user intention when participating. A psychological theory to predict human behavior, the Theory of Planned Behavior (TPB) model (Ajzen, 1991) is employed as the theoretical framework in Chapter 4. In the TPB model, behavioral intention is a function of three factors: attitude (A); subjective norms (SN); and perceived behavioral control (PBC). The model is augmented with extrinsic and intrinsic motivators. It proposes an extended model to explain the intentions of online community members when participating in online community challenges and idea generation activities. The research model was empirically tested with two samples (the online communities of Atizo and Nokia). Structural equation modeling was used due to the sample size. For the collected survey data, partial least squares (PLS) data analysis method was used since this method employs a component-based approach for estimations to evaluate relationships within a structural equation model.

Data collecting methods used:

- For the cross-case synthesis, four European city halls (Amsterdam, Barcelona, Helsinki, and Berlin) and four public or private organizations (the Waag Society, Amsterdam Innovation Moto (AIM), 22@barcelona, and Forum Virium) that act as POI intermediaries were selected on the basis of their relevance and accessibility as the primary data; as well as the participants of an Open Cities project meeting in Barcelona. Later I conducted in-depth interviews with those local government policy researchers and the research directors of public agencies who were identified as the most knowledgeable individuals with respect to the innovation process in these eight organizations. These in-depth interviews provided the most effective way to explore the innovation process in the public sector. Secondary data, such as online research, analysis of organizational websites and reports, scientific journals, and validation by key informants were also collected.

- The data for examining the underlying mechanisms of on-line open innovation intermediaries (online data from 51 open innovation intermediaries) was collected through secondary sources such as published academic literature, and data collection from their websites. Further semi-structured interviews with on-line open innovation intermediaries (Atizo, dotOpen, Innoget, and Ideasproject) were conducted to gain a better understanding of their mechanisms.

- The survey data necessary for the investigation of motivations and factors affecting the participation was collected from the Atizo and IdeasProject platforms. Before implementing the survey, data was collected from: structured in-depth interviews with Christian Hirsig (manager of Atizo) and Pia Erkinheimo (Head of Crowdsourcing at Nokia); participant observations in their internet platforms; informal talks; working documents; and log files for their all projects.

Given the inductive nature of the research, Chapter 2 adopts a qualitative multiple case study approach to illustrate the current role of public open innovation (POI) intermediaries in the innovation process of local governments (Eisenhardt, 1989; Yin, 2003). Data was analyzed in two steps: (1) brief case analysis with background information and examples of some projects; and (2) a detailed cross-case analysis based on characteristics of the collaboration, benefits, challenges, and future of collaboration. The cross-case analysis enabled a comparison between different cases and defined patterns and differences (Eisenhardt, 1989).

For the research on mechanisms in Chapter 3, 51 on-line open innovation intermediaries are initially clustered into five distinct groups based on their functions and underlying mechanisms. Interviews and secondary sources were used to perform clustering. These mechanisms were then briefly examined from the algorithmic mechanism design perspective, and their limitations and tensions examined. Results of mechanism design analysis were contrasted with insights gained from interviews.

To test the Theory of Planned Behavior (TPB) model in this open innovation intermediary context in Chapter 4, a web-based survey of the Atizo and IdeasProject communities was conducted (Ajzen & Fishbein, 1980; Ajzen, 1991). This validated and extended the model at an individual level to explain the participation of users in two contexts: open innovation

intermediaries and a crowdsourcing platform. Using the insights gathered in the exploratory analysis, a SEM-PLS model was employed that was based on a mix of surveys from the participants in the on-line platforms and hard data (mostly on real participation) gathered directly from the platform. The election of a PLS schema seems more adequate because of its minimal demands in terms of sample size and its better fit with soft theory models.

Therefore, this research examines open innovation processes and the role of public open innovation intermediaries across Europe in the public sector (Chapter 2); and further analyses the underlying mechanisms (Chapter 3) with online platforms as the unit of analysis, and the supporting motives and factors (Chapter 4) of open innovation intermediaries with the focus on an individual level.

1.1.7 Structure of the thesis

The remainder of the dissertation is organized as follows. Chapters 2, 3, and 4 are structured as independent papers and each embraces its own section of research questions, literature review, methodology, results, and discussion.

In Chapter 2, open innovation intermediaries in the public sector are explored. This chapter also contains the results of in-depth interviews with public open innovation intermediaries and city halls that enabled a cross-case analysis of the roles of these intermediaries in city hall innovation ecosystems.

Chapter 3 initiates a description of the mechanisms of on-line open innovation intermediaries and an analysis of the five main mechanisms arc types using algorithmic mechanisms design theory.

Chapter 4 includes a comparative analysis of the main incentives in Atizo in order to characterize the innovation process in private on-line open innovation intermediaries – including IdeasProject, a crowdsourcing platform. The survey conducted at both intermediaries is based on a modified version of the theory of planned behavior (TPB), and is further augmented to partition both extrinsic and intrinsic motivators.

Chapter 5 presents an overall review of the thesis with the main contributions, policy, and managerial implications, limitations, and future research.

The thesis consists of two separate volumes. The first is the thesis and the second is the appendix containing all the related appendixes for each chapter and additional research that was conducted during my PhD studies.

1.1.8 Chapters Summary and Findings

A summary of findings with contributions and implications from dissertation chapters is presented in Table 1.1 below:

	Chapter 2	Chapter 3	Chapter 4
Research Questions	• How do public and private agencies function as POI intermediaries? • How do local governments govern these intermediaries and manage the information flow? • What are the main benefits and obstacles encountered by both local governments and public intermediaries? • What kind of policy implications can be derived?	• What are some main archetypes of open innovation intermediary mechanisms? • What specific processes are supported by these mechanisms? • What are the underlying tensions, pitfalls, and limitations of these mechanisms? • What are the managerial implications for the choice and use of open innovation intermediaries?	• What are the underlying motives behind participation in online open innovation communities? • Which factors and motives have a greater impact on the intention to participate? • How can platforms improve their mechanisms in order to attract more participants?
Research Setting	• Four city halls: Amsterdam, Berlin, Barcelona, and Paris • Four public or private organizations: the Waag Society, Amsterdam Innovation Moto (AIM), 22@barcelona, and Forum Virium	51 online open innovation intermediaries	Platforms of Atizo and IdeasProject (Nokia)
Unit of Analysis	Public and private organizations	Online platforms	Individuals (members of platforms)
Research Design	Cross-case synthesis technique supported by qualitative data (both primary and secondary)	Algorithmic mechanism design supported by qualitative data (both primary and secondary)	PLS analysis supported by qualitative data (both primary and secondary)

Key Findings	• Open innovation intermediaries interact with city halls in a similar manner across Europe. They act as a bridge across the large cognitive distances between city halls and a network of organizations, while orchestrating the collaboration of actors and executing innovation projects. • City halls do not have a strategy or structure for governing these intermediaries and collaboration	• Identification of five main mechanism archetypes • Most of the mechanisms fail to resolve the tension, autonomy, and recombination of ideas • It is better to use a small number of experts capable of solving well defined problems. Large numbers of agents excel better at solving ill-defined unclear problems. Many of the mechanisms are situated at a midpoint • A conflict between the use of monetary incentives and non-monetary incentives (i.e. fun) is better suited for the exploration of novel outcomes. Most of the mechanisms favor the use of monetary incentives with low upper thresholds	•Innovation intermediaries are not homogeneous due to the large variance in their purpose so their underlying mechanisms vary to a similar degree • Differences between the two platforms are revealed. In both platforms, intrinsic (specifically enjoyment and sense of self-worth) rather than extrinsic motives predominate. • The impact of attitude is greater than norms on intention to participate. • Self-assessed participation model is not as accurate and correlates negatively with a real participation model.
Contributions	• Exploring the presence of open innovation intermediaries in the public sector • Providing a framework for the role of open innovation intermediaries in city hall innovation ecosystems • Providing implications for policy makers	• Disclosing distinct mechanism archetypes employed by on-line open innovation intermediaries • Revealing some important underlying variables that are generalizable across mechanisms that vary with purpose will expand the open innovation, TPB, and intermediary literature • Assess the heterogeneity of participant needs and decide how to react and increase user commitment • Derive the tensions and limitations of each mechanism (as well as providing managerial implications) • Providing managerial implications on the use of open innovation intermediaries and improving the design of these platforms	• Revealing main motivations and factors that affect the participation of people in on-line open innovation intermediaries • Exploring which rewards (extrinsic or intrinsic) and constructs (attitude, subjective norm, perceived behavioral control) have more impact on the intention to participate • Providing insight to the managers of open innovation intermediaries
Implications	• City halls should support them by increasing the pool of funds	• The absence of collaboration and monetary	• Subjective norms have less impact on intentions

	and providing further autonomy in their decision making, while pursuing more interaction and collaboration at all levels • City halls should assist and guide public intermediaries in creating various communities that can lead to greater innovativeness • City halls should create, coordinate and maintain part of the ecosystems (especially important for the formation and support of SMEs, start-ups) since new networks and clusters are crucial for the growth of a regional economy.	prizes in broadcasting search will probably hamper the discovery of new solutions, creativity • Brainstorming with ranking provides more innovative solutions due to collaboration • Exploratory problems should opt for mechanisms that foster collaboration at the expense of incentive compatibility. • Complex problems could be easily adapted by an expert group. • Firms have to choose (depending on the problem) which of two drawbacks – recombination and autonomy – associated with each approach is less significant in terms of producing the best outcome.	compared to attitude due to the absence in online environments of past experience such as shared norms; impact of geographical dispersion leads to differences in norms, and impact of virtual world • Observed divergence between self-assessment and reality due to overrating by participants of their own participation and future commitment, the heterogeneity of the online community, the fact that people have different motives • Sense of self-worth varies among participants • The explicatory power of the TPB model is high when using self-assessed data, but not with real data • Intrinsic motivations, such as sense of self-worth and enjoyment, are crucial to attract participants • There should also be active support for collaboration and networking among members • Intermediaries require the development of other support mechanisms for non-extrinsic motives

Table 1.1: Summary and findings of dissertation chapters

1.1.9 Additional research and projects:

During my PhD, I have participated in two European Union projects, one regional and one specially prepared for the European Commissioner for Research, Innovation, and Science. These projects enabled me to access most of the companies that I have conducted research

on and led me to write a teaching case, a journal article, and a research report that can be found in the appendixes. My detailed contributions in these projects and the details of this research are listed below.

In the Open Cities (Open Innovation for Future Internet Services in Smart Cities) European Union project, I was responsible for managing and completing a work package about open innovation in the public sector. Real experiments have been implemented in online platforms and mechanisms such as crowdsourcing, open data, and open sensor networks in a number of cities. During this project, I collaborated with various public organizations such as Barcelona, Amsterdam, Berlin, Helsinki, and Paris city halls, as well as private organizations such as Cap Digital, the Waag Society, Fraunhofer, ForumVirium, Barcelonactiva.

I also participated in the FIREBALL (Future Internet Research and Experimentation) project and was responsible for development and knowledge transfer on best practices of future internet innovation in the pilot city (Barcelona). With the data gathered from this project, a paper, 'A Smart City Initiative: The case of Barcelona', was published in Journal of the Knowledge Economy.

For IA5 (Acceleration Paths towards Innovation and Competitiveness) regional research project, I was responsible for designing and developing a set of technological assets to ease the adaptation to open innovation by companies across Europe. To achieve this, 15 case studies across Europe were completed and including large companies such as IBM, Nokia, StatoiHydro, Fortis, KLM, BBVA. A teaching case, Quilts of Denmark: Managing Open Innovation in a Low-Tech Industry SME, was written with one of the cases from this project. It is published in ECCH, 2010.

Recently, I participated in the preparation of a research report to be presented to Máire Geoghegan-Quinn, European Commissioner for Research, Innovation, and Science in Brussels in June; and during the European Commission's Innovation Convention December 2011 together with Wim Vanhaverbeke and Henry Chesbrough. We designed and presented future European innovation policy recommendations about open innovation and IP management strategy for open innovation practice & IP management. This was achieved by analyzing best practices in four economic sectors: ICT/technology; pharmaceuticals/life science; energy and

chemicals, by collaborating with leading companies such as Microsoft, BP, Pfizer, ETH Zurich, and Truffle Capital.

Chapter 2: The role of public open innovation intermediaries in local government and the public sector[1]

2.1 Abstract

In order to achieve a high level of innovativeness, cities are in collaboration with public and private organizations that allow city halls to tap into networks of companies and clusters as well as execute projects. This article focuses on this kind of public or private firm, public open

[1] This research will be published in a forthcoming issue of the Technology Analysis and Strategic Management journal and it was presented in Academy of Management Conference, Boston 2012.

innovation (POI) intermediaries, which operate in the public sector. An exploratory multi-case study was conducted with the participation of POI intermediaries and local governments in Finland, Germany, the Netherlands and Spain. The eight cases reveal that certain public or private companies act as a bridge – POI intermediary – across the large cognitive distances between city halls and a network of organizations, while orchestrating the collaboration of actors and executing innovation projects. These findings motivate policy makers to enhance the innovativeness and competitiveness of cities, and they offer useful guidelines for city halls to improve their innovation process and remove possible obstacles.

2.2 Introduction

While external ties with established firms, universities and research institutes are important, city halls and municipal governments may encounter considerable difficulty in developing ties with these prominent organizations. Networks and clusters in particular play an even more important role in the innovation process of city halls, because they have traditionally been considered as key ingredients in firms' success. Thus city halls, the legislative bodies that govern cities, began to address open innovation in response to the growing importance of networks and increasing competitiveness among European cities (Parkinson *et al.*, 2004).

Citizens are gradually observing a transition in many areas of local government, as authorities evolve from being mere service providers to platform managers who run projects and collaborate with third parties and citizens. This process is similar to the process in the private sector, where competition is increasingly becoming established at the level of the ecosystem.

This process was more evident in certain areas, for example in European projects such as the 'Open Cities' and 'FIREBALL – Future Internet Research and Experimentation' projects. These two projects are ultimately about bringing innovation, particularly open innovation, and innovation management to the agenda of city governance. In both projects we observed uncharted intermediary types – POI intermediaries.

In the context of open innovation management, the role of intermediaries has been investigated thoroughly (Dosi, Llerena & Sylos-Labini, 2005; Howells, 2006). One type of intermediary focuses on the sourcing of innovation, examples here being Innocentive, Ninesigma and yet2.com. These private intermediaries help private companies to participate in the secondary markets for intellectual property and the sourcing of ideas, proposals and technologies that will subsequently be incorporated into other organization products and services (Giaglis, Klein & O'Keefe, 2002; Chesbrough, 2006).

It is therefore a legitimate and interesting question to ask whether similar intermediaries exist in the public sector and, if so, to analyze the role they play. There is, however, a lack of research that specifically defines POI intermediaries and explores their role in innovation processes in the public sector. In this paper, POI Intermediaries are defined as public or private organizations that intermediate between city halls and other organizations. Therefore, this paper addresses this issue by means of an exploratory multiple case study approach conducted across Europe with four local governments in Finland, the Netherlands, Germany and Spain, and four public and private organizations that act as public innovation intermediaries.

With the help of the case studies, this paper aims to explore and analyze POI intermediaries across Europe, while addressing the following research questions:

(1) How do public and private agencies function as POI intermediaries?

(2) How do local governments govern these intermediaries and manage the information flow?

(3) What are the main benefits and obstacles encountered by both the local governments and the public intermediaries?

(4) What kind of policy implications can be derived?

Therefore, this paper seeks to provide a framework for addressing the question of how public innovation intermediaries are involved in the innovation process of city halls. We achieve this by reviewing the literature on intermediaries. First, we will present the existing research on intermediaries in the relevant literature and the theories relating to their role in innovation processes.

Next, we will examine European cross-case studies that provide both POI intermediary and city hall perspectives. A supporting source survey was also used and this was developed and completed by some of the organizations participating in the Open Cities project. Following analysis of the cases and the results of the surveys, the public innovation intermediaries and their role in the innovation processes of city halls are defined. There follows a discussion of the general role of public intermediaries in local government innovation processes. The final, concluding section suggests policy implications for policy makers who seek to foster innovation with these intermediaries.

2.3 Literature review

As the extant literature on innovation has highlighted, firms' search for innovation spans both internal and external sectors of knowledge space (Rosenkopf & Nerkar, 2001; Katila, 2002). This claim also holds true for city halls. Similar to private firms, the innovative ideas and solutions to the problems of city halls can be provided both internally and externally through collaboration with public and other organizations (Fung & Weil, 2010). This external knowledge space can be supported by POI intermediaries.

Expressed simply an intermediary is a third party, a firm or a person that acts as a mediator and offers intermediation services between two other parties. Intermediaries may be private organizations, individuals, experts or advisors in the form of retailers, distributors, wholesalers, platforms, media companies, agencies and financial institutions (Aoki, 2001; Howells, 2006). The general intermediary literature was examined from several perspectives covering various strands of thought in the 1986–2012 period (Chesbrough, Vanhaverbeke & West, 2006; Lakhani *et al*., 2007). Table 1 lists all the main studies associated with intermediaries in innovation.

Among these various intermediary types, considerable attention has been devoted to innovation intermediaries. Innovation intermediaries are acknowledged as external organizations or individuals that support companies in their innovative activities by gathering, developing, controlling and disseminating external knowledge, while providing various

resources and regulating the innovation networks (Howells, 2006; Stewart & Hyysalo, 2008). As Chesbrough (2006) mentioned, intermediaries can operate in different ways; some function as agents (representing one side of a transaction) and others as brokers (representing both sides of a transaction).

Despite the fact that research on innovation intermediaries has been developed since the 1990s, most of the studies have continued to focus solely on the role of the intermediaries' work for private organizations, while only a few have addressed the performance of the innovation intermediary in innovation processes (Hargadon & Sutton 1997; Lichtenthaler, 2005; Howells, 2006; Lichtenthaler & Ernst, 2008; Stewart & Hyysalo, 2008). Furthermore, no more than a few studies focus in detail on the whole range of innovation intermediaries (Stewart & Hyysalo, 2008). Tran, Hsuan and Mahnke (2011) consider the added value of innovation intermediaries in new product development, and a multiple case study by Sieg, Wallin and von Krogh (2010) analyses the managerial challenges, providing possible remedies for the companies that work with an innovation intermediary. However, all these studies focus on innovation intermediaries that collaborate with private rather than public organizations.

Term	Study	Definition
Intermediaries	Watkins and Horley (1986); Seaton and Cordey-Hayes (1993); Braun (1993); Stankiewicz (1995); Stewart and Hyysalo (2008); Gassmann, Daiber and Enkel (2011)	A third party, a firm or a person that acts as a mediator and offers intermediation services between two other parties
Knowledge brokers	Hargadon (1998); Hinloopen (2004); Verona, Prandelli and Sawhney (2006); Ramirez and Dickens (2010); Hussler, Muller and Rondé (2010)	An organization that span multiple markets and technology domains and innovate by brokering knowledge from where it is known to where it is not
Innovation Intermediaries	Howells (1999b, 2006); Lichtenthaler and Ernst (2008); Sieg,Wallin and von Krogh (2010); Tran, Hsuan and Mahnke (2011); Nambisan, Bacon and Throckmorton (2012)	An organization that acts an agent or broker in any aspect of the innovation process between two or more parties

Table 2.1: Summary of studies examining intermediaries in innovation

As the concept of open innovation has grown in importance, innovation intermediaries drew more attention (Chesbrough, Vanhaverbeke & West, 2006; Lakhani *et al.*, 2007). Open innovation is a model for the management of innovation in which companies open up their innovation processes and combine internally and externally developed ideas and technologies to create value (Chesbrough, 2003). The 'open innovation' concept has quickly attracted the interest of both researchers and practitioners. It is illustrated by a number of special issues, such as the special issue of R&D Management (Gassmann, Enkel & Chesbrough, 2010) and TASM (Galbraith & McAdam, 2011).With the exception of the study by Laursen and Salter (2006) and many empirical cases, open innovation literature has not yet been examined using a large dataset. Despite the continuous expansion of open innovation literature, there are a number of critiques, such as questioning the novelty of the concept (Trott & Hartmann, 2009) and the negative aspects of the concept (Elmquist, Fredberg & Ollili, 2009).

Despite the increasing prominence of POI intermediaries in practice, there is almost no specific theoretical or empirical guidance. In order to advance the literature, we investigated the role of POI intermediaries in the innovation processes of local governments, while examining how and under what conditions this interaction can be enhanced by certain public policies across Europe.

2.4 Methodology

Given the inductive nature of the research, this paper adopts a qualitative case study approach to illustrate the current role of POI intermediaries in the innovation process of local governments (Eisenhardt, 1989; Yin, 2003). The study was initially guided by a literature review and exploratory interviews to derive findings from the cases through a process of inference and sense making (Weick, Sutcliffe & Obstfeld, 2005), and ultimately develop an inductive structure. Exploratory multiple case studies of four European city halls and four public or private organizations that act as POI intermediaries were selected on the basis of their relevance and accessibility. This research design was chosen on the basis that it suits research questions, it enriches our understanding of the research context (Saunders, Lewis & Thornhill, 2003) and it also provides a detailed description of the relationships that exist in confined contexts (Galliers, 1992). We explored the role of public intermediaries in the innovation processes of government through a combination of primary data, such as case studies and surveys, and secondary data, such as online research, analysis of organizational websites and reports, scientific journals and validation by key informants. Eight semi-structured, in-depth interviews were organized with the policy researchers of local governments and the research directors of public agencies who were identified as the most knowledgeable people with respect to the innovation process. These interviews were conducted during the Open Cities project meetings in Barcelona in the course of 2011 and lasted an average of between two and three hours. The main themes that were discussed in these interviews were (1) the background to and characteristics of the collaboration, including causes, characteristics and functions; (2) projects (criteria, role of each identity, management); (3) the main challenges; and (4) the future of the collaboration. The four city

halls interviewed were those in Amsterdam, Barcelona, Helsinki and Berlin. Subsequently, we conducted interviews with four public or private organizations that act as POI intermediaries: Waag Society, Amsterdam Innovation Moto (AIM), 22@barcelona and ForumVirium. We also included the case of Technologiestiftung Berlin (TSB - Technology Foundation Berlin), an agency of Berlin City Hall, based on secondary sources collected and the views of a senator from Berlin City Hall about TSB. Thus, as an analytical technique, a cross-case synthesis is set up. The level of the analysis corresponded to the public or private organizations that act as POI intermediaries. Europe-wide selection of cases that would provide insight into different aspects created heterogeneity to allow comparative analysis and established external validity. In order to achieve construct validity, we triangulated the data by exploiting a combination of multiple sources as mentioned earlier, and we conducted a common structure of questions and a framework for the analysis of each case (Eisenhardt, 1989; Yin, 2003). In addition, the draft of the interviews and the cases was checked by the key informants, and reliability was recognized by using multiple sources of information (Miles & Huberman, 1984). Moreover, this research attempts to reach similar results (Yin, 2003). Data analysis involves two steps: (1) brief case analysis with background information and examples of some projects, and (2) a detailed cross-case analysis based on characteristics of the collaboration (involving the role of each identity, project criteria, management and events), benefits, challenges and the future of the collaboration. The cross-case analysis is used to compare different cases and define certain patterns coupled with differences (Eisenhardt, 1989). Cross-case synthesis technique allowed us to treat each individual case separately, and their subsequent assembly served to aggregate findings that lead to an understanding of the wholeness and unity of the cases (Punch, 1998). Below, multiple cross cases will be illustrated.

2.5 Business case descriptions

2.5.1 Barcelona City Hall and 22@barcelona

As the second largest city in Spain and the fifth most attractive European city for business, Barcelona participates in a number of projects to pioneer open innovation through the Smart City initiative. At the Eurocities Knowledge Society Forum 2010, the head of the international cooperation department at Barcelona City Hall emphasized that one of the main objectives of Barcelona's Smart City initiative is the improvement of networking that supports open innovation. Barcelona City Hall follows a triple helix model which is based on collaboration between companies, universities and the public sector for innovation. To achieve this, and for the purpose of other projects, Barcelona collaborates with various economic agents. For example, Barcelona's regional agency analyses and creates technical proposals for insights on urban development and infrastructure[2]. One of the oldest initiatives is Barcelona Activa, is a local development agency in Barcelona established in order to design and execute labor policies while creating and consolidating companies[3]. It also aspires to promote innovation by offering expert advice, specific training and other resources. It coaches over 1000 new projects a year and hosted 139 innovative start-ups in 2011 alone at its Business Incubator and Technology Park. Another important agency is 22@barcelona, a public-funded company which is responsible for particular projects, one example being 22@Urban Lab, a project designed to transform and attract talent to a specific industrial district in Barcelona, retain this talent and create an ecosystem by 2022. I n this district, a number of innovative pilot programmes have been put into practice and subsequently implemented as new services and products (see Figure 1).

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[2] Ajuntament de Barcelona 2011. International Economic Promotion of Barcelona City Council. Economic Agents. http://w42.bcn.cat/web/en/per-que-barcelona/agents-economics/urbanisme-mercat-immobiliari.jsp.

[3] Barcelona Activa, 2011. All About Barcelona Activa. http://www.barcelonactiva.cat/.

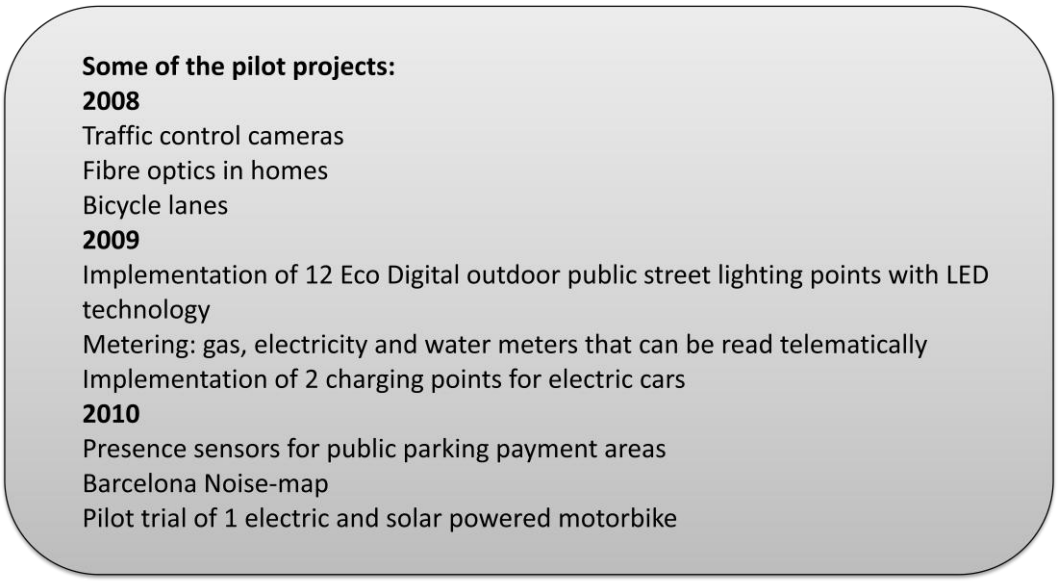

Figure 2.1: Some of the pilot projects

2.5.2 Amsterdam City Hall and Waag Society & Amsterdam Innovation Moto

The Amsterdam Metropolitan Area, with high gross domestic product (GDP) per capita, a central location and an excellent transportation and information and communications technology (ICT) infrastructure, helps businesses tap into the most attractive worldwide customer markets and outstanding international trade routes. It is therefore no surprise that over 2000 multinational companies are concentrated in this area, which acts as an attractive test market. Furthermore, Amsterdam is rapidly becoming the software and IT capital of Europe. A number of local agencies collaborate closely with companies and the city hall in order to foster innovation within the city. Amsterdam Innovation Motor (AIM) was founded by the city of Amsterdam, the Chamber of Commerce, the University of Amsterdam and a number of companies in order to solve problems in the city and the area around Amsterdam. The aim of this organization is to stimulate innovation in all fields, with a particular focus on life sciences, financial services, creative industry and ICT. Similarly, Waag Society is a not-for-profit private research organization, partially funded by national and local government, and with considerable funding from long-term EU research projects. From 1998 to 2012, it has

been operating as a prototype and pilot creator, creating new services and products together with both the public and the private sector. The 'Apps for Amsterdam' contest is a major initiative developed by Amsterdam City Hall, Waag Society and Hack de Overheid. The latter is a community of hackers, as well as entrepreneurs, journalists and officials, who cooperate on innovation based on open government data. The aim is to stimulate open data and its applications, while seeking to make as much data about the City of Amsterdam available as possible[4]. While the role of the City of Amsterdam is funding the contest and providing the data, Waag Society builds the network between the City of Amsterdam and Hack de Overheid and manages the contest. Similarly, AIM runs the Amsterdam Smart City project, which uses technology to increase the efficiency and quality of life of the city.

2.5.3 City of Helsinki and Forum Virium

The innovation policy of the City of Helsinki is shifting from a supply-driven to a demand- and user-driven approach, with the implementation of the new innovation policy in 2010 (Työ-ja Elinkeinoministeriö, 2010). This new approach requires new activities and a network of companies, so Helsinki City Hall needs Forum Virium, a not-for-profit private organization, as a public innovation intermediary. Forum Virium is a policy instrument to inspire innovation and ideas, while developing and delivering new citizen-focused services for economic development in areas such as energy, health care and urban living. It is partially funded by the city hall and member companies, and it receives major funding from both local and European projects. Increasingly, most of the start-ups and SMEs in the Helsinki region are using the channels of Forum Virium. The IT Director and chief information officer (CIO) of the City of Helsinki, who is also a member of the Working Committee of Forum Virium, considers that it is crucial to build a network with the stakeholders and organizations in order to support the new innovation approach. Increasingly most of the start-ups and small and medium-sized enterprises (SMEs) in the Helsinki region are using the channels of Forum Virium. In order to

[4] Apps for Amsterdam, 2011. All submitted Apps for Amsterdam, May 4. http://www.appsforamsterdam.nl/alle-apps.

further stimulate the innovativeness and development of the city of Helsinki, municipalities in the Helsinki region have decided to use Open data competitions – Helsinki Open data competition[5] and Apps4Finland[6] – to implement the policy of 2010. Forum Virium launched these competitions to develop mobile applications by utilizing open data and attracted the programmers. Some examples of the Apps4Finland competition are shown in Figure 2.

Figure 2.2: Examples from the Apps4Finland competition

There are also other agencies such as the Healthy Helsinki platform, which focuses on e-health projects and Smart Urban Spaces, which is devoted to new service infrastructure and delivery platforms.

2.5.4 Berlin City Hall and TSB Technology Foundation Berlin

Berlin has the most compact university and institute setting in the whole of Europe, with 60 research institutions and seven universities.[7] This research setting has an industrial network

[5] Helsinki Region Infoshare 2011. Open regional data. http://www.hri.fi/en/.

[6] Apps4Finland, 2011. Suomen Verkkodemokratiaseurary. http://apps4finland.fi/fi.

[7] Berlin, 2011. Das offizielle Hauptstadtportal (Berlin's official Internet site). http://www.berlin.de/.

that offers companies optimal conditions for research and development. Within this setting, Berlin City Hall aims to promote innovation and improve cooperation between industry and research institutes, creating an opportunity for institutions to present their research and projects, and enabling organizations to tap into this research. The senator of Berlin's Department of Economics and Labor, defined Berlin City Hall's four agencies: (1) Berlin Partners, responsible for economic development and public relations abroad; (2) Investment Bank (IBB of Berlin) committed to the reconstruction of Berlin, and mainly engaged in investment, part of which goes towards funding innovation; (3) the Chamber of Commerce for the development of Berlin and its surrounding area; and (4) the Technology Foundation of Berlin (TSB), a group which is responsible for most of the networks in the principal fields of innovation with the exception of ICT, e.g. traffic, health and energy. TSB is an independent private entity that promotes of science and technology, while managing innovative networks and initiating collaborative projects in selected areas that are developed together with the city hall. TSB has been involved in a variety of projects, one of which is the 'Learning laboratories network GenaU' in the region of Berlin–Brandenburg, which has developed into a hub for the promotion of science and technology among young people; at the same time, it has served as a bridge between research and schools, allowing students to experiment and train in the laboratories.[8] Here, TSB managed the coordination between 11 laboratories and institutes, while maintaining GenaU the network.

2.6 Cross-case analysis results

2.6.1 Characteristics of the collaboration

Many cities frequently encounter an enormous task of infrastructure development when seeking to provide better services and to enhance the innovativeness of the city. Both these

[8] GenaU, 2009. Student laboratories in Berlin and Brandenburg. www.genau-bb.de.

goals are complex and require the involvement of various parties: public and private parties, citizens, resources and networks. This is why collaboration between the city hall and public innovation intermediaries' collaboration is considered an effective strategy for addressing such issues. Such collaboration makes it possible to accomplish objectives that neither entity is able to achieve alone. It also creates knowledge transfer and combines the expertise of all entities. This would eventually lead to better outcomes and desired solutions. The collaborations that we observed in this study had many similarities. Collaboration took place between city halls and public intermediaries who were motivated to cooperate in order to develop innovative services as the outcome of projects that they could not easily pursue alone.

Role of each identity

Public innovation intermediaries have a significant role as the key enabler in the innovation strategy of city halls. For example, Barcelona Activa implements the innovation policy of Barcelona City Council by building networks, sustaining collaboration and providing necessary resources during the execution of projects. Thus, in all cases it is observed that each of these public or private organizations acts as an intermediary (a bridge) and a project executor. The very first role of public innovation intermediaries is to build networks of organizations and then be the first to attract all the project ideas from these networks. As political organization, city halls are at a distance from latest technologies, developments and innovative ideas, as well as the demands for new services and products, as the policy researcher from Amsterdam explained. This creates an opportunity for POI intermediaries to reduce the cognitive distance through bridging. In this way, they collaborate with other public and private organizations, citizens and universities to promote innovation and economic development based on a range of sectors. These partnerships strengthen competitiveness and innovative abilities. Based on the needs of the city, POI intermediaries filter the ideas and present those selected to city hall. The head of Strategic Sectors and Innovation at 22@barcelona summarized their role as follows:

> "For citizens, 22@Barcelona forms of the city council. They are not aware that we are an independent public organization that simply collaborates

> with Barcelona City Hall. Thus we serve as a bridge between the city council, companies and citizens."

Similarly, the research director of Waag Society explained their role as follows:

> "We see ourselves as a bridge between the government and other intermediaries. We are kind of an intermediary where different people, organizations and points of views meet, and we try to help them to change, to adapt or to take an opportunity."

The second key role of public innovation intermediaries is project execution. 22@barcelona executes projects while reporting the results to the city hall and the policy researcher in Economic Affairs Amsterdam defines the role of public intermediaries by giving them assignments. For example as Amsterdam City Hall wishes to invest in life sciences, AIM or Waag Society will be asked to attract companies, build networks, initiate projects and coordinate these. The bottom line task for AIM or Waag Society is to synthesize these parts and see how they can innovate together. Each organization has a role and they consider themselves as an office that helps these different institutes to understand each other. Not only do they implement the city guidelines, they also support the ideas and interests of the network communities. Thus POI can be defined as the hub of technology and innovation.

It is observed that some POI intermediaries focus on a particular community of public or private organizations, such as start-ups in Barcelona, hackers and programmers in Amsterdam, and SMEs, start-ups and programmers in Helsinki. Each POI intermediary uses various mechanisms, such as online apps challenges in Amsterdam, or workshops in Helsinki, in order to attract these specific communities.

Through the case analysis, it is observed that city halls like Amsterdam, Berlin, Barcelona and Helsinki have a central role as policy makers. However, they have deficiencies with respect to project execution, and this is why they require public innovation intermediaries. As a city hall, they can decide which problems need solving and which issues are the most essential, but they do not have enough networks or sufficient capacity to execute projects. In general, city halls provide financing and incentives for projects and/or legislative support, such as offering opportunities for experimentation. As in the case of 22@barcelona, city halls also provide

companies with an opportunity to test and knowledge transfer in a real life setting, with a lower risk of market failure. Eventually, city halls expect to receive improved products and services for citizens through the outcome of these projects. The interaction of city halls with public innovation intermediaries is quite official and exists at different levels. In some cases, and Forum Virium is an example here, the board members of the intermediary include various representatives of the city hall, or they monitor the projects on a regular basis with reports, as in the case of Amsterdam City Hall. In other cases, the city halls may play a more active role in their continuous progress, such as in the case of mobile technology services in Helsinki.

The findings also suggest that POI intermediaries interact with city halls in a comparatively similar manner. They intermediate between companies and government by gathering all the possible proposals suggested by companies, and providing networking, screening and selection of the right solutions and projects for governments. This interaction between city halls, public innovation intermediaries, and public and private organizations is represented in Figure 3.

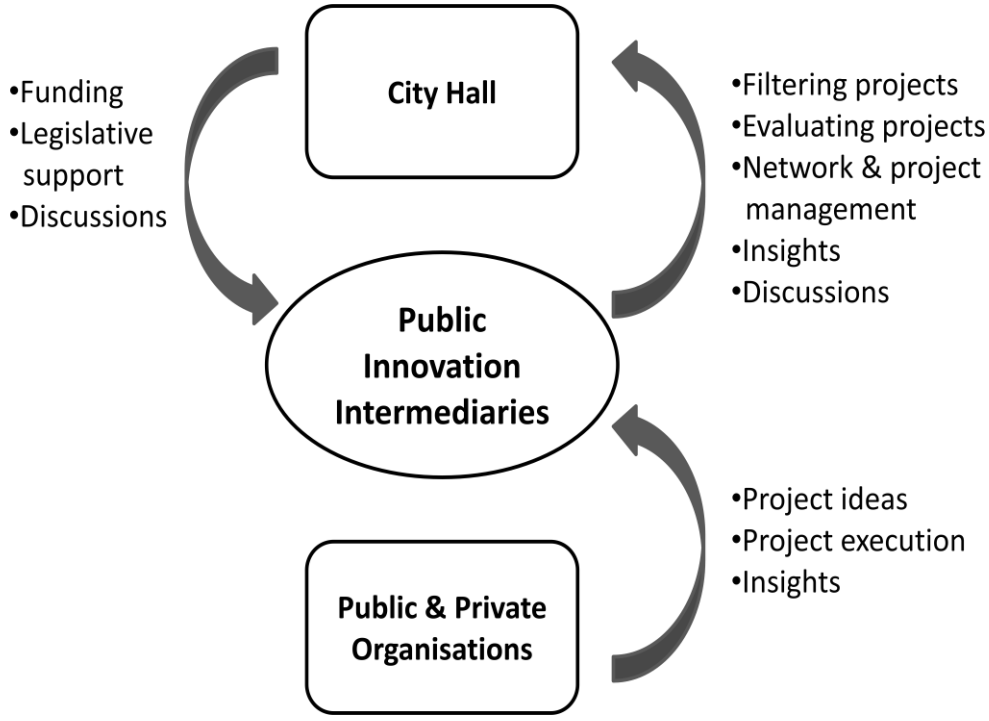

Figure 2.3: Innovation process between Public Innovation Intermediaries and City halls

The innovation process also highlights the similarities and differences between POI intermediaries and private intermediaries and their interaction with city halls and companies. POI intermediaries act as a platform for assisting government in meeting its challenges by opening its boundaries in the same way that private intermediaries do for companies. However, public innovation intermediaries also assist government in the decentralization of control through network and project management and implementation, filtering and evaluating projects provided by organizations, and gathering insights and discussions for government strategies. The main difference is that private innovation intermediaries have a community of experts who solve the problems of organizations, mainly for private companies. Furthermore, public intermediaries are involved in project execution, whereas in the case of private intermediaries only pilot or prototype projects are created.

Project criteria

Each city hall applies different criteria when selecting a project proposal. For example, Forum Virium and Helsinki City Hall select proposals that are socially crucial and feasible, applying a user-driven approach while, seeking to strengthen the role of the Helsinki area as an innovation platform both nationally and internationally. Similarly, the senator of Berlin explains the criteria employed by Berlin City Hall as follows:

> "The most important criterion is the economic idea behind the proposal. Which market offers a new opportunity for products and services? Is there an opportunity for employment? These are the main factors when making a decision."

Management

Another common finding from these cases was the fact that the city hall does not have any strategy or structure for governing these intermediaries and the collaboration. For example, Amsterdam City Hall does not have any control with respect to intermediaries' decisions. They simply have consultations and some discussions at a random base. The degree of control and organization is higher in Helsinki. However, the system is more of a bottom-up information flow without any strategy for managing it.

Events

Public innovation intermediaries organize various events such as talks, conferences, panel discussions and workshops in order to create awareness, increase the participation and collaboration of companies and public departments, and encourage brainstorming on public issues. Barcelona Activa, TSB and Forum Virium often employ these events to bring organizations and public departments together. The events also create a platform for organizations to meet and coordinate. Forum Virium, in particular, emphasizes the importance of these events, at which it acts as a matchmaker, combining ideas with the needs of public departments, while gaining an overview of their network. These events are also organized to present and report their activities on city hall, TSB being an example in this respect.

Benefits

City halls benefit from the collaboration with the POI through their enabling role in the formation of clusters, spillovers and mergers. At the same time, competitiveness is enhanced and the development of innovative ideas is fostered. Through the interaction with these networks, POI can provide the market insight that city halls lack. As an outcome of these interactions, project execution and reduction in cognitive distance is achieved – difficult tasks for city halls owing to their political nature. These benefits are clearly observed in all cases. The new clusters also attract new firms to the area and create economic growth. Through these networks, industrial partners are motivated to collaborate with other players in their environment who are usually competitors. There can also be sector-specific benefits, such as in the case of Berlin City Hall, which takes advantage of the collaboration by creating opportunities for SMEs to implement their innovations, while providing services such as support in the preparation of projects and suggestions on funding opportunities. SMEs also expand through the construction of networks, the provision of consulting services and funding, as in the case of 22@Barcelona. Similarly, POI can overcome obstacles such as the bureaucracy problem for participating companies in Helsinki. Overall, companies that participate in projects gain visibility and publicity, and they receive an opportunity to demonstrate of their products and services. For example, organizations in the 22@barcelona area can redevelop their solutions, and test them with the end users, citizens. The case of TSB

also showed that such collaborations create an opportunity for scientists to gain access to new technological developments and partners from academia and industry.

Challenges

As the case studies demonstrated the complexity of intermediation tends to be underestimated. The common challenges for intermediaries are mainly conflicts of interest, bureaucracy, budget restrictions, collaboration and control problems. Conflicts of interest between city hall and POI represent an important challenge, which can be seen in collaborations as a whole. In the case of Helsinki, for example, in some projects there was a mismatch between the expectations of organizations and those of city hall regarding the resultant services and products. Likewise, expectations that are not very clear can cause an obstacle, as occurred on occasions between AIM and Amsterdam City Hall. According to Amsterdam City Hall this is due to the distance created by the division of policy making and project execution. Another challenge is the collaboration with other municipal areas when the project is bottom up, as in the case of Barcelona. 22@barcelona suggested transversal programs to solve this issue. Budget restrictions caused by the 2008 financial crisis and bureaucracy are other common challenges.

It is observed that the remaining the challenges vary slightly from case to case. These slight differences may be due to demographic, economic or functional differences. For example, Berlin cited the management of projects or collaborations as the main challenge, while Waag Society said it is difficult to find someone to take responsibility from inside city hall and it takes longer to initiate or to persuade the key persons. On occasions, Helsinki City Hall does not approve funding for private companies, only public companies, whereas in some cases private companies prefer not to apply for public funding, since they then have to be more open with their results. Once intermediaries overcome these challenges, they can play a more important role in structuring demand in the context of new services.

The future of the collaboration

It is expected that in the future there will be more collaboration of this kind between city halls and public innovation intermediaries. For example, Amsterdam City Hall aims to structure the entire system of government in a different way, based on the triple helix model. In the case of

Helsinki, the future of the city's development depends to a great extent on the successful cooperation of organizations and citizens with government. All these future innovation plans depend heavily depend on the existence of the organizations like Forum Virium, Waag Society, TSB, etc. Thus the role of these organizations is vital to the innovativeness of the cities, despite the fact that in some cases they dissolved and joined city hall, as in the case of 22@barcelona.

2.7 Discussion

One of the most relevant transformations that has occurred in innovation is the change of locus, from the R&D departments of large companies and universities to networks (Tuomi, 2002). This transformation, fostered by IT and the Internet, has certainly increased the output in terms of innovation by raising the chances of connecting and recombining ideas. However, it has also led to a novel problem: the need to maintain active networks in which innovation can flourish.

In the private sector, these networks have evolved into ecosystems driven by a common goal of competing to provide novel and better products and services. However, in the public sector, the mechanisms that could align all the actors to a single goal are not so evident, because actors are not directly engaged in competition for a market share, as they are in the private sector. Therefore, citizens and civic innovators, to name but two constituencies, are not naturally engaged in the innovation ecosystems of cities and regional governments.

Facilitating this engagement is one of the roles of POI intermediaries in the Public Sector. In fact, in the description of the cases we can observe how each intermediary effectively taps into one or more constituencies, actively maintaining a network through the use of a diversity of mechanisms. For example, Waag Society in Amsterdam engages software developers and the Open Source community and actively maintains this network through permanent installations like Fablab or ad-hoc events such as developers' or hackers' days.

Forum Virium, Waag Society and 22@ focus on the same role, but they aim at a different constituency: companies, particularly innovative companies in the ITC sector and SMEs. The mechanisms for maintaining these networks are also different from those employed by Waag Society, for in this case workshops, projects, conferences or networking events were observed that aimed at connecting companies with cities and with each other. In addition, more formal mechanisms are used, such as direct participation in different kinds of boards and commissions.

The presence and maintenance of these networks is essential in order to be able to actively engage these communities and mobilize them in projects. Actively maintaining these networks requires not only commitment and specialization but also leadership and the capacity to be regarded as a real member of the community. These two characteristics are far beyond the reach of city halls, and the role of these organizations as intermediaries is key to solving this problem.

> **Proposition 1**. POI intermediaries in the Public Sector maintain active networks with constituencies such as web developers, SMEs, start-ups, hackers, the Open Source community, etc., thereby facilitating their participation in the innovation ecosystem of cities.

City halls, often characterized as large bureaucratic organizations, maintain substantial cognitive distances with communities of innovators, entrepreneurs, hackers, start-ups or SMEs, characterized as being at the opposite end of the spectrum. However, these are the types of communities where innovation flourishes. The innovative intermediary organizations presented in the cases effectively bridge and connect both worlds, supplementing the internal capacity of cities and enabling them to tap and incorporate the knowledge and practices of these communities.

Inter-agent interaction is essential for innovation in order to facilitate knowledge recombination (Hargadon, 2003), or to validate and co-develop novel solutions so that new meanings may emerge (Tuomi, 2002). In this interaction, cognitive distance plays an important role; it should not be excessive, lest it prevent understanding, or should it be so small and that it enables the generation of non-redundant knowledge (Nooteboom, 2000).

Marrying these two contradictory objectives is certainly difficult. However, by bridging and mediating between communities, POI intermediaries offer a novel approach to this problem, facilitating the interaction and understanding of agents when large cognitive distances exist, and therefore maximizing the opportunities for novel solutions and by extension, innovation.

The idea of acting as a bridge between two kinds of organizations to facilitate understanding can be found in all the cases portrayed, either in an explicit and rationalized manner or underlying the case description.

> **Proposition 2.** POI intermediaries in the public sector bridge the considerable cognitive distance between city halls and innovative communities, enabling interaction between these communities and cities, and thereby facilitating knowledge recombination, the co-development of novel solutions and the emergence of new meanings through interaction

When examining innovation in the public sector, it is important to remember that the nature and objectives of the innovation process are different in comparison with innovation in the private sector.

If the objective in the private sector is focused on the development of a novel proposal that could be adopted by the market, the public sector has a broader mandate encompassing not only the development of novel solutions, but also, and most importantly, the facilitation of innovation activities in the city. This is the reason why the descriptions in the cases refer to collaborative project implementations, such as in Apps4finland and 22@urbanlab, rather than focusing on specific products or services.

The complementarity of the visions of cities and intermediaries is of particular interest. Intermediaries portray themselves as bridges between different communities, while cities regard themselves as facilitators and managers of projects.

It is also important to observe the duality of the role of these intermediaries. On the one hand, they collaborate in the implementation of city guidelines by orchestrating projects around them. On the other hand, the cases presented show how these organizations promote

their own agendas based on the interests of the communities with which they intermediate, and so they have a role as public entrepreneurs.

It is in this context that these two propositions come together nicely. Maintaining active networks and reducing the cognitive distance are both necessary conditions and the underlying reason why these intermediaries exist, since these roles cannot be performed by the cities themselves. Likewise social network studies also showed the importance of network bridges in transferring knowledge in networks but also as a source of innovation (Burt, 2004).

At this point, it would be interesting to continue to discuss the role of these intermediaries in a wider context, in which the cities are orchestrators of innovation ecosystems around them and these intermediaries are necessary agents for the activation of these ecosystems.

> **Proposition 3.** POI Intermediaries create value by orchestrating the collaboration of actors and communities in cities through innovation projects. They act as public entrepreneurs and are necessary agents in the activation of city innovation ecosystems.

2.8 Policy implications

If cities wish to remain competitive and innovative in the knowledge economy of the next decades, then policy makers have to make the process of collaboration with POI intermediaries easier, address the main challenges that emerge and seek to exploit the benefits. We derived the following policy implications:

- Public intermediaries should exist and compete with each other. For their own benefit, city halls should support them by increasing the pool of funds available and providing further autonomy in their decision making, while pursuing more

interaction and collaboration at all levels.

- Public intermediaries have to address different constituencies and different communities. Since diversity leads to greater innovativeness, city halls should assist and guide public intermediaries in creating various communities.

- City halls should create, coordinate and maintain part of the ecosystems. These networks are especially important for the formation and support of SMEs, start-ups and spin-offs. Building up new networks and clusters is crucial to the growth of the regional economy and innovativeness.

2.9 Conclusions

The main problem in the private sector is the sourcing of novel and relevant ideas in a search space enlarged by globalization and Internet to the extent that it has become global. In the public sector, however, where the objective is not exclusively finding new solutions but also building and activating ecosystems to meet the challenges of society, the main problem to solve is how to effectively connect and engage communities around these challenges. Therefore, even if the mediating and bridging role remains the same, the objectives, methodologies and the underlying problems that require solving are quite diverse.

Since the role of innovation intermediaries is a mediating role, it is heavily dependent on the existence of an ecosystem maker that can provide it with structure and governance. Even though we are at the early stages of understanding this, the introduction of ecosystems changed the way that we understood competition and innovation in the private sector, and it will probably do the same in the public sector, where POI intermediaries will play a different, but increasingly important role.

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Chapter 3: The underlying mechanisms of open innovation intermediaries[9]

3.1 Abstract

The popularity of open innovation as a methodology for sourcing innovation opens a novel perspective on the increasing value of accessing and competing in innovation. When practicing open innovation, organizations face the challenges of identifying useful solutions and partners in a universe that is not confined to the boundaries of the firm. To address these challenges, online open innovation intermediaries have grown in number and achieved a global presence in recent years and this has led to an increasing interest in research that explores their roles and functions.

[9] This research is under review for a forthcoming issue of the Research Policy. An earlier version of this has been published in Service Innovation Yearbook 2010-2011 of European Commission and it was presented in R&D Management Conference, Manchester 2010.

Intermediaries employ a variety of mechanisms to leverage the motivations of intermediary platform participants (solvers and search agents) and influence their behavior. There is, however, limited research that specifically explores these matching mechanisms and consequent outcomes. Accordingly, this analysis develops a classification of mechanism archetypes and a formal analysis through algorithmic mechanism design descriptions. These mechanisms were analyzed in terms of incentive compatibility and reveal the underlying tensions, pitfalls, and limitations of existing mechanisms – while providing managerial insights on their appropriate use.

3.2 Introduction

It is difficult to imagine how a society can maintain its well-being without growth and the pursuit of growth is a focal element of much economic policy. In a free market economy, growth is enabled by the competitive exploitation of novel innovations. Since an increasing number of actors are able to operate on the frontiers of technology, the effective exploitation of novel innovations is considered fundamental for competitive advantage.

The need to compete in innovation is behind the popularity of open innovation as a method for opening the search space beyond the boundaries of the firm as a source of innovative solutions and competitiveness. Open innovation suggests that the innovation performance of companies can be enhanced by incorporating innovations created outside the boundaries of the firm to the internal development processes, as well as actively promoting internal innovations that do not match the business model with opportunities outside the firm. In other words, open innovation embraces the process of cultivating and internalizing values from opportunities external to the firm, as well as the skilful deployment of internal discoveries to external deployments (Chesbrough, 2003).

Because the objective is to connect with relevant actors beyond the existing network of the participating companies, open innovation intermediaries normally opt for using, totally or partially, a technological platform that allows them to operate globally and so become on-line open innovation intermediaries. An internet-based technological platform enables easy

connection to the open innovation intermediary by providing awareness of both the needs of seekers and the offers made by solvers. An innovation platform is the locus where much or all of the matching process takes place. Incentives are provided in the form of cash prizes and non-monetary awards that signal reputation. Negotiations such as licensing or co-development, together with the process of refining the proposed solution, often take place in this venue.

Sourcing innovation outside the boundaries of the company could effectively provide a solution to the innovation problem, but at the same time, creates a new problem: how to select, connect, and engage the best solution among the vast number of existing possibilities? In response to these needs, a new set of actors has emerged who aim to provide original solutions to these challenges. In recent years, the number of open innovation intermediaries has increased substantially with an increasingly global coverage.

Their novelty, rapid growth, and consequent success (Piller et al., 2010) have led to increasing interest and research in how they provide value for clients. Specifically, research has offered a broad view of how open innovation intermediaries function and has explored some aspects of their operations in matching innovation supply and demand (Lakhani, 2007; Boudreau et al. 2008; Jeppesen et al. 2010). However, these intermediaries have different structures due to the various underlying mechanisms that leverage participant incentives for intermediary platform members (solvers and search agents) to increase and direct their participation. There is a lack of research that specifically explores the matching mechanisms used by open innovation intermediaries. Here, the incentives and behavior of individual agents can be considered as seekers and providers of potential solutions, and how these attributes are embraced, formed, and aligned with the platform infrastructure.

Examining the area of on-line mechanism design in detail, some research was found that focused on on-line platforms (Parkes, 2007) and prediction markets (Pennock & Sami, 2007). However, open innovation intermediaries have not been researched from the point of view of mechanism design. Mechanisms present interesting characteristics because the objectives of the intermediary often cannot be accomplished by exclusively promoting full information revelation. Other aspects need to be considered such as cognitive and behavioral biases,

search strategies, information asymmetry, or as in this case, the recombination of ideas through collaboration.

Our analysis employs mechanisms designed to analyze the organizational structure of open innovation intermediaries as platforms utilizing privately held information. Mechanism design permits the analysis of incentive-compatibility in the design structure of the platform, identifying potential conflicts and undesirable behavior. Specifically, the following research questions were addressed:

- What are some main archetypes of open innovation intermediary mechanisms?
- Which specific processes are supported by these mechanisms?
- What are the underlying tensions, pitfalls, and limitations of these mechanisms?
- What are the consequent managerial implications for the choice and use of open innovation intermediaries?

To address these research questions, several important antecedents of open innovation intermediary mechanisms were identified from a combination of primary data (multiple case studies) and secondary data (from professional, scientific, and online sources). The mechanisms along two dimensions of interest were placed: a) their ultimate objectives that range from finding the 'right' connections between actors to finding the 'right' solutions to challenges; b) their level of support for recombination as a basic process for creating innovative solutions.

Our overall findings suggest that information intermediaries are not homogeneous and the underlying mechanisms with which they support their operations vary substantially – more so than the existing literature suggests. Specific findings of this research include:

i. The identification of five mechanism archetypes: 1) broadcasting search (directed and undirected); 2) brainstorming with ranking (directed and undirected); 3) networking / connect; 4) expert group; and 5) License-out.
ii. There is a common tension between autonomy and the use of recombined ideas that can be seen through comments that aim to foster innovation while remaining incentive-compatible. Most of the mechanisms fail to resolve this

tension and opt for either using recombination at the cost of letting the agents gain by misrepresenting their valuations of the ideas of others; or using autonomy to circumvent the use of recombination.

iii. There are certain contradictions between the two extremes of the objective of the mechanisms. At one extreme, the phenomenon of using a small number of experts capable of solving well-defined problems was found. At the opposite end, a large numbers of agents who excel at solving ill-defined and unclear problems were found. Many of the identified mechanisms are situated at a midpoint between both extremes, failing to communicate and engage with either a large number of users or the best experts in specific fields.

iv. There is a conflict between the use of monetary incentives (i.e. money) that favor the reuse of existing solutions, and non-monetary incentives (i.e. intrinsic pleasure) that are better suited for the exploration of novel outcomes. Most of the examined mechanisms favor the use of monetary incentives with low upper thresholds, and a limited ability to create recognition and awareness among a community of users.

Based upon these findings, this research contributes to existing literature by: a) presenting a new research discourse that considers online open innovation intermediaries from the point of view of their platform mechanisms; b) disclosing the distinct mechanism archetypes employed by open innovation intermediaries; c) highlighting some important underlying variables that are general sable across mechanisms that vary with purpose; d) revealing the tensions and limitations of each mechanism; and e) providing managerial implications on the use of open innovation intermediaries.

3.3 Literature review

Even though both strands, open innovation intermediaries and on-line mechanism design, have been comprehensively analyzed separately, there is still a lack of connection in the literature characterizing the mechanisms used by open innovation intermediaries. Thus first open innovation intermediary literature will be focused on, then on-line algorithmic

mechanism design and finally we will link these two strands in order to characterize and discuss the mechanisms used by open innovation intermediaries in the following section.

3.3.1 Open innovation intermediaries

The intermediary literature has been examined from various perspectives over the past decades (Chesbrough et al. 2006; Lakhani et al. 2007). The research in this area grew with the rise of a distinctive type of intermediary: innovation intermediaries. Howells (2006) delineates an innovation intermediary as 'an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties' (p.720). Thus, by charging for their services, intermediaries can considerably reduce the research and bargaining transaction costs for companies. Moreover, innovation intermediaries help companies participate in the secondary market for intellectual property.

Most of the studies on innovation intermediaries generally focus on the role of intermediaries in the innovation process (Lichtenthaler, 2005; Howells, 2006). Stewart and Hyysalo (2008) identified the broker role as 'creating spaces and opportunities for appropriation and generation of emerging technical or cultural products' (p.306). These activities can include collecting, developing, broadcasting, and eliminating knowledge and information. Specifically in his paper, Howells (2006) provided an extensive analysis of literature in which he defined the main conceptual strands and concluded that most of the studies have not been well-grounded theoretically. Similarly, Winch and Courtney (2007) emphasized the innovation enabling role of those intermediaries by showing that intermediaries 'focus neither on the generation nor the implementation of innovations, but on enabling other organizations to innovate' (p.751). Chesbrough (2006) also emphasizes the role of intermediaries in helping the movement of ideas; enabling ideas to flow out of places where they do not fit and find a place in other companies where they fit better. Lakhani et al. (2007) explored knowledge brokering as a new way of escalating the value of external sources of innovation through an analysis of Innocentive.

A few studies used classifications and frameworks for intermediaries in the literature, but they mainly focused on the role and function of intermediaries (Howells, 2006; Stewart 2008;

Diener & Piller, 2010). For instance, Howells (2006) provided ten functions based on different roles and functions of innovation intermediaries. Likewise, the framework of Stewart (2008) not only explores the functions of intermediaries in the innovation process, but also maps intermediaries based on four dimensions: the supply-side (business to business environment); final use; design in use; and use in development. Recently, Diener and Piller (2010) analyzed 43 open innovation intermediaries based on their methods, sectors, costs, and project structures. However, these classifications of intermediaries only approximate the general activity of innovation intermediaries, which, due to their novelty and the continuous appearance of new proposals, remains fairly open.

With the rise of the open innovation concept, one type of innovation intermediary, the online open innovation intermediary, has received greater attention in the recent years (Chesbrough, 2006; Lichtenthaler & Ernst; 2008, Lakhani et al., 2007). Solving the problem of selecting, connecting, and engaging potentially successful innovations at a global level is not within the reach of many companies, even if large. Open innovation intermediaries address this problem with a variety of approaches, ranging from creating communities to crowdsourcing or maintaining a network of potentially relevant contacts that could be exploited a posterior. Thus, open innovation intermediaries act as agents who cultivate knowledge while representing one or both sides of a transaction in which ideas, intellectual property, and technologies are exchanged (Chesbrough, 2006). The literature is mainly composed of single or multiple case studies of intermediaries (such as cases on NineSigma, yet2.com, and Innocentive) and is mainly focused on managerial implications (Huston & Sakkab, 2007; Lakhani et al., 2007). Only a few empirical papers have been written on open innovation intermediaries (Lakhani et al., 2007) and most of these are focused on performance (Lichtenthaler & Ernst, 2008; Howells, 2006).

3.3.2 Mechanism design

Mechanism design is a sub-theme of game theory that deals with a particular class of private information game where the designer can choose the game structure and is interested in its outcome. Thus, mechanism design goals are best defined in the context of social choice – which is an aggregation of the preferences of the participants toward a single mutual decision.

Mechanism design aims to devise a system to implement desired social choices or the desired choices of the owner of the system in a strategic setting where the agent preferences are private – such as in auctions (Nisan et al., 2007). Chung and Ely (2007) analyzed an auction setting where the mechanism designer can rationally choose a dominant strategy mechanism to maximize revenue. Likewise, Huang et al (2010) examined the mechanism design for e-procurement auctions where the appropriate incentive such as a bonus will lead the supplier to make more effort to deliver higher quality goods or services.

Overall, the literature of mechanism design is focused on the design of optimal mechanisms with the objective of profit maximization (Wilson, 1993) and socially efficient mechanisms (Groves, 1973). Within the optimal mechanisms, companies such as open innovation intermediaries lack private (member) information, so they design methods to reveal their preferences. Open innovation intermediary platforms can therefore be defined as multi-agent environments with self-interested members. However, within the literature of mechanism design, on-line mechanisms and prediction markets are the closest mechanism models that fit with open innovation intermediary contexts due to the unclear choices of multi-agent/members on online platforms. Thus a review of these literature strands will highlight the research gap that this paper addresses.

As a concept, online mechanism design was proposed by Friedman and Parkes (2003) following the study of Lavi and Nisan (2000) on truthful mechanisms in dynamic environments. With the rise of Internet, the methods of mechanism design have extended to a more dynamic environment where online mechanisms are required (Nisan et al., 2007). In online mechanisms, information is revealed online and the decision must be made dynamically without knowledge of the future, including prospective agent types and their potential decisions (Parkes, 2007). Thus, the basic setting of online mechanism design involves risk neutral agents that act to maximize the expected difference between its value from a sequence of decisions and its total payment while assuming that agents have quasi-linear utility functions (Parkes, 2007). Parkes' (2007) paper emphasizes that the current literature is limited regarding the design of revenue-maximizing online mechanisms in a model-based environment.

Prediction markets aim to solve the information aggregation problem by relying on the information of a large number of agents in order to predict future events (Nisan et al., 2007). Thus, a prediction market is a mechanism designed to extract a forecast for a random variable or set of variables through aggregating knowledge and opinions about the likelihood of future actions (Pennock & Sami, 2007). The concept roots back to the theory of rational expectations of Muth (1961) and Lucas (1972), where empirical research on prediction markets focuses on the accuracy of prediction markets via laboratory or field testing (Pennock & Sami, 2007, Tziralis & Tatsiopoulos, 2007, Berg et al., 2008). Additional studies conducted analyze financial markets (Tetlock, 2006) and the manipulation of prediction market prices (Rhode & Sctrumpf, 2006). Pennock and Sami (2007) survey the literature on prediction markets and focus on algorithmic challenges and constraints associated with implementing a prediction market mechanism.

To our knowledge there are only few studies and frameworks that address in detail the whole range of innovation intermediaries and intermediary mechanisms. Yoo and Kim (2012) investigated the ranking mechanism design of music charts of an online digital music distributor. Likewise, Strausz (2012) and Rahman and Obara (2010) analyzed mediated contracts with mechanism design. Only the study of Antikainen and Väätäjä (2008) focused on reward mechanisms in online open innovation intermediaries. Giaglis et al. (2002) focused on pricing, logistic, trust, and infrastructural mechanisms within intermediaries while analyzing the role of intermediaries in electronic marketplaces. They also concluded that the role of intermediaries varies with the actual mechanism used in the platform.

In short, while both the strands of literature have been studied in depth, to our knowledge, few synergies have been found between these lines of research. Moreover, the review of earlier research has shown that the general mechanism design of innovation intermediaries has not yet been examined. The following section describes and analyses the underlying mechanisms of online open innovation intermediaries.

3.4 Research design

This analysis is based on data collected from 51 open innovation intermediaries through: (1) primary sources such as semi-structured interviews with four intermediaries, and; (2) secondary sources such as published academic literature, official reports, and company websites. As such, there were two major activities:

a. On-line data collection: websites of the 51 intermediaries were visited and the relevant information grouped, classified, and clustered.
b. Semi-structured interviews with open innovation intermediaries: interviews with six managers, researchers, and directors of four open innovation intermediaries were conducted: Atizo; dotOpen; Innoget; and Ideasproject.

Data collected from the interviews and secondary sources was used to perform clustering and derive the archetypes. These results were then contrasted with the insights arising from the interviews.

3.5 Characterizing on-line open innovation intermediaries

The first element for characterizing open innovation intermediaries is the interaction process that takes place within the platform. At one extreme, an approach is identified such as that of Atizo which fosters collaboration among participants. Others use the platform as a search tool that looks for solutions provided by individual partners. Examples of this second approach include Ideaken or Innocentive.

This first dimension is very informative as it characterizes the mechanisms in terms of incentives and group dynamics. A second dimension comes from identifying the objective of open innovation intermediaries – ranging from selecting, connecting, engaging, and implementation. In this continuum, a significant difference exists between finding potentially relevant partners and identifying concrete solutions with or without the corresponding implementations.

Figure 3.1 provides a visualization of some of the intermediaries considered across these two dimensions. A third dimension, the size of the intermediary graphic logo – which correlates with the size of its community, was added.

Figure 3.1: Clustered online open innovation intermediaries

This clustering exercise allowed us to identify five distinct clusters and therefore their underlying mechanisms. These mechanisms were termed as: 1) broadcasting search (directed and undirected); 2) brainstorming with ranking (directed and undirected); 3) networking/connect; 4) expert group; and 5) license-out (Figure 3.2). These five mechanisms will be briefly examined while providing examples that illustrate their description.

	Collaborative	Non-collaborative
Search for new partners	Networking	• License Out • Connect
Search for new solutions	• Brainstorming • Expert groups	Broadcasting search

Table 3.1: Online open innovation intermediary mechanisms

3.5.1 Broadcasting search (directed /undirected)

Probably the most immediate approach to the search problem presented by open innovation is to publish the challenge to a vast audience and hope that somebody has either developed a solution in similar or dissimilar contexts, or identify somebody with the appropriate knowledge who is willing to develop a solution. In any case, the aim is to take advantage of a large population of solvers to further exploit existing solutions that could be partially or completely applied to the problem. Consequently, the mechanism that was characterized as broadcasting search was among the first used by open innovation intermediaries and because of its highly public success stories, it has proved one of the most popular mechanisms.

In broadcasting search, companies post their problems and requirements to communities with a pre-set monetary award for the best solutions. Mostly, this problem or need is defined as a challenge. Thus, intermediaries such as Innocentive act like knowledge brokers between 'problem seekers' (companies with problem or need) and 'problem solvers' (Lakhani, et al. 2007). For instance, in the case of Innocentive and NineSigma, corporate problems are posted as challenges on the platform and innovators are invited to submit their proposals.

One distinctive feature in this mechanism is that seeker companies work in consultation with the operations staff of the intermediary in the process of preparing the description and requirements of the problem or need; screening the submitted proposals; monitoring the process; or guiding the community.

Similar to the directed version of the broadcasting search mechanism, undirected broadcasting search also involves companies in the same steps of posting their requests to the community platform seeking innovations (such as ideas, patents, and innovative products and technologies). However, this variant of the mechanism does not provide any support or monitoring during the process.

Thus broadcasting search as a mechanism offers a market view of the innovation process, where externally generated solutions are matched to internal projects. It was observed that most of these intermediaries (such as Innocentive (RTP), Ideaken, Ninesigma (RTP), and Innovation Exchange) follow this type of mechanism.

3.5.2 Brainstorming with ranking

Broadcasting search works well when there is a clearly defined problem. However, many problems, especially when they are in the exploratory phase, are poorly defined. A mechanism that addresses this particular situation is brainstorming.

In brainstorming with ranking, companies post their problem and detailed requirements to a community and look for unexpected solutions or ideas. Ideas are generated and collected in a brainstorming phase. The best ideas are then picked and the award divided. Here the main role of community is to generate ideas through brainstorming and filter them through voting. Similarly to the undirected version of the broadcasting search mechanism, undirected brainstorming provides no support or monitoring during the process.

For instance, the 'Idea Projects' of Atizo is a service for brainstorming projects in which the main role of the Atizo community is brainstorming, generating new ideas, and filtering them online through an internal voting system. The role of the company who sponsors the 'Idea Project' is also crucial, as they need to clearly prepare a clear concept and monitor the process in order to achieve a better result. Whereas Atizo could subsist by only providing a service bridging the customer with the community and does not monitor the process. Other intermediaries (such as Openideo) provide monitoring during the brainstorming process.

3.5.3 License out

Rather than publishing a challenge seeking possible solutions, unused solutions can also be posted seeking potential adopters who may find them of value. This is precisely the objective of the license-out mechanism. Although a similarity with broadcasting search is evident, there remains a clear point of divergence. In this case, companies do not look for solutions, but for relevant leads that can eventually result in the use of existing solutions in new contexts.

This mechanism involves a licensing-out agreement between organizations and community members and provides companies and people with a way to publish their ideas; market-ready products; or market-ready technologies. For instance, Innoget provides a service in which companies can offer their innovations in terms of patents, ideas, innovative products, or technologies to the community.

Similarly yet2.com cultivates the connection between needs (mainly technological) and capabilities through their online technology marketplace for licensing available know-how in terms of a patents, products, or even ideas. They also assist companies in the process of needs identification and solution decision. Thus yet2.com acts more like a licensing agent and enables innovators to post their innovations for companies to examine. Intellectual property brokers aid innovators in finding buyers for their patents; while licensing agents help innovators find firms interested in licensing patented technology.

3.5.4 Connect – networking

While well defined solutions are important, companies also understand that developing their networks without an immediate objective is also worthwhile. This is why organizations not only look for solutions, but may also have an interest in communicating within their ecosystems to develop opportunities for collaboration. Organizations seek investors, startups, partners, and customers by creating a profile with their interests and projects. However, only a few intermediaries provide such a service as it is difficult to obtain financial fees for this kind of interaction.

For instance, dotOpen is an online communication platform for organizations that works in a similar way to a LinkedIn for companies, within which decision-makers can research, discover, and contact potential clients, competitors, investors, suppliers, and other partners. The platform enables firms to find similar organizations, upload projects and interests, rate, and follow other organizations and share. Tools are being developed to improve their users' ability to strategically collaborate.

3.5.5 Expert groups

Expert groups have always revealed themselves to be important in the creation process; a recent example is the reliance on 'interpreters' in design driven innovation (Verganti, 2008). Open innovation intermediaries are uniquely positioned to provide these services by connecting companies with groups of experts that could assist in validating and providing ideas that could be included in present or future strategies.

Intermediaries that implement the 'expert group' mechanism include Atizo (concept groups), Ninesigma, Big Idea Group, and Ideas to Go. These intermediaries harness the expertise of their community to solve well-defined challenges or tasks (e.g. building a prototype). The intermediary builds an expert group for a specific challenge or task, either through selecting the group members from the community or by hiring them for a position in the group.

All these mechanisms were summarized in Table 3.2 and highlight the main participant motivations and incentive structures.

Name of Mechanism	Mechanism description	Companies	Main motivations
Broadcasting search	Directed broadcasting search: - Companies post to community their requests (problem or need) with details and requirements - A pre-set monetary award for the best solution is offered - No collaboration within the community - The whole process is supported and monitored by experts	Innocentive (RTP), One Billion Minds, Brainrack	Extrinsic > intrinsic (Monetary rewards such as awards or cash)
	Undirected broadcasting search: - Companies post their requests (a call for ideas; market ready products, technologies to License) with details and requirements - A pre-set monetary award for the best solution - No collaboration within the community - Not supported and monitored by the experts	NineSigma , Innovation Exchange, Battle of concepts, Challenge.gov, Top Coder, BeeQuu, Innoget (Ibox-in), Hypios, Ideaken	Extrinsic>intrinsic (Extrinsic motives- Monetary rewards such as awards or money, affiliation)
Brainstorming (with ranking)	Directed brainstorming search: - Companies post their requests (problem or need) with details and requirements - A pre-set monetary award for the best solution - Ideas are collected in brainstorming phase & filtered through voting - Customers pick the best ideas and divide the award - Collaboration within the community - The whole process is supported and monitored by experts	Openideo, Brain Reactions, Big Idea Group, eYeka, My Startbucks Idea	Intrinsic > extrinsic (Intrinsic motives: fun, enjoyment. Extrinsic motives: visibility, reputation)
	Undirected brainstorming search: - Companies post their requests (problem or need) with details and requirements - A pre-set cash award for the best solution - Ideas are collected in brainstorming phase & filtered through voting - Customers pick the best ideas among them and divide the award - Collaboration within the community - Not supported and monitored by the experts	Atizo (Idea generation), Brainrack, Brainfloor, Ideas Project, Dell IdeaStorm, Idea Bounty , Hyve, Quirky, ideas4all, Ideas to Go	Intrinsic > extrinsic (Intrinsic motives: fun, enjoyment. Extrinsic motives - visibility, reputation)
License out	- Companies and individuals aim to License-out innovations (patents, innovative products, and technologies) to community	Pharmalicensing, Idea Connection, Inpama, BeeQuu, Edison Nation, Innoget (Ibox-out), Yet2.com	Extrinsic>intrinsic (Extrinsic motives - visibility, reputation,

			agreement)
Connect/ Networking	- Companies use platforms to discover and contact potential clients, competitors, investors, suppliers, and other partners - To build an ecosystem based on what they are looking for (solutions to common industry issues, regional or cross regional)	Idea Crossing, Brainrack, dotOpen (communication platform), Ninesigma (Linked InnovationSM), Inpama	Extrinsic>intrinsic (Extrinsic motives: visibility, networking)
Expert groups	- Intermediaries generate expert groups from the community according to the defined needs and problems of companies	Atizo (concept groups), Big Idea Group, Your Encore, Ninesigma, Ideas To Go, Innovation Exchange, Idea Connection, Gen 3 Partners	Extrinsic > intrinsic (Extrinsic motives- Monetary rewards or affiliation, visibility)

Table 3.2: Summary of five mechanisms

3.6 An algorithmic perspective

From a formal point of view, an online open innovation intermediary is an on-line electronic market where a number of participants endowed with a well defined utility function representing their preferences behave in a self-interested rational way and aim to optimize their utility. Such rational self-interested participants were termed as agents. Such an electronic market functions on the basis of established rules of conduct that can be formally described in an algorithm. Agents are motivated through a payment and such a solution is termed as a mechanism.

Definition 1. A mechanism $m = (f, p_1, \dots, p_n)$, consists of two elements, an objective function f and a tuple of payments $< p_1, \dots, p_n >$

Specifically,

a) A mechanism defines for each agent a set of possible strategies $a \in A$.
b) Each agent has private information termed type $\theta \in \Theta$ that acts as a signal; as well as a valuation function $v_i\ (\theta_i, a_i)$ that specifies a value for each possible alternative.
c) A mechanism enables an allocation rule $f(v_1, \dots, v_n) \epsilon A$ that determines an output function $f = f(a, \dots, a_n)$.
d) A mechanism provides a payment $p_i = p(a_1, \dots, a_n)$ to every agent.

Definition 2. (An implementation). A mechanism is an implementation with dominant strategies (in short an implementation) if for each agent i there is a strategy $a_i \epsilon A$ such that for all possible other strategies of all other agents a_{-i} , a_i maximize its utility $u_i = p_i + v_i\ (a_i)$.

Definition 3. (Mechanism design optimization problem). In this mechanism definition problem when given a set of possible outputs L and an objective function $L(f, \theta)$, termed social choice (which is concerned with relationships between individual preferences and social choice), an output $f \epsilon L$ is required that maximizes L or in the appropriate case and given a factor c, it is required that any other output $f' \epsilon\ L$, $L(f, \theta) \leq c\ L(f', \theta)$.

A key definition in the area is incentive compatibility (also called truthfulness). Intuitively, it can be said that a mechanism is truthful if agents can never gain by lying or not revealing the truth, that means that a player i will prefer to tell the truth $v_i$to the mechanism, rather than a possible 'lie' v_i' , because $v_{\ i}$ gives him a greater utility. Formally,

Definition 4 (Incentive compatibility). A mechanism $m = (f, p_1, \dots, p_n)$ is called incentive-compatible if for every player i and every $v_1 \epsilon\ V_1, \dots, v_n \epsilon V_n$ and every v_1' we have $v_i(a) - p \geq\ v_i\ (a') - p'$ where $a = f(v_i, v_{-i}\ )$, $a' = f(v_i', v_{-i}\ )$, $p = p_i\ (v_i, v_{-i})$ and $p' = p_i\ (\ v_i', v_{-i})$.

Online open innovation intermediaries use various mechanisms. Most of these mechanisms share the objective of focusing the attention of the solvers towards a specific proposal called a challenge. A process of successive bidding occurs until the seeker values and rewards them accordingly to a preference function.

Therefore an objective function is achieved that consists of the contribution of ideas or solutions and their associated payments. The objective of the mechanisms is to maximize the objective function and produce a selection of the best ideas diverse enough to cover all or most requirements.

Overall notable differences exist, however, in the implementation. These differences range from the level of involvement of the intermediary in the preparation of a selection of challenges to the extent that collaboration between the agents is fostered or allowed. It is therefore interesting to examine to which degree the different implementations could succeed in optimizing the objective function while being incentive-compatible. Moreover, this research aims to explore the conditions necessary for maximizing the objective function together with the limitations imposed by each specific implementation.

3.6.1 Broadcasting search

The underlying mechanism of Innocentive has been studied in detail (Lakhani et al., 2009) and is described as 'broadcasting search'. Briefly, Innocentive distinguishes between two types of agents: seekers and solvers. Seekers are agents that propose problems (known as challenges) and solvers suggest solutions. Innocentive distinguishes between four type of challenges that all share the same mechanism, namely: ideation challenges; theoretical challenges; reduce to practice (RTP) challenges; and request for proposals (RFP) challenges.

Mechanism: Broadcasting search

Input: challenges $c \in C$ - *challenges proposed by seekers*
payments $p \in P$ - *payments rewarding solvers*
solvers $a \in A$ - *agents addressing the challenges*
Output: solutions $s \in S$ - *proposed solutions*

Mechanism: *Broadcasting search :* $(c, p, a) \rightarrow s$
repeat
for each $c \in C$
$s_i \leftarrow sol(a_i)$ - *agents propose solutions*
return *s* - *set of solutions developed by solvers*
end

Given an agent i with a solution s_i and a valuation $v_i\ (s_i)$ let us assume that agent i declares $v_i^{'}(s_i^{'})$ where $v_i^{'}(s_i^{'}) < v_i\ (s_i)$. It therefore risks that an agent j proposes s_j with $v_j\ (s_j)$, where $v_j(s_j) > v_i^{'}(s_i^{'})$, and so wins the prize. Therefore it is in the best interest of agent i to reveal s_i(truth) instead of $s_i^{'}$ (lie).

Proposition 1. The maximization of the objective function in broadcasting search depends on the number, expertise and diversity of the participant agents.

The utility for an agent i of proposing a solution $s_i \in S$, can be divided into three parts: a potential prize $p \in P$; a valuation $\omega_i\ (c)$ capturing learning, awareness, networking, etc.; and a cost $cost_i\ (s_i)$. This gives $u_{\ i}(s_i) = p_i + \omega_i(c) - cost_i\ (s_i)$ and given that agents are self-interested therefore $u_i\ (s_i)$ must be positive, thus implying $p_i + \omega_i(c) > cost_i(s_i)$, which solves when $cost_i(s_i) \simeq 0$ or when the likelihood of winning (or the valuation of the challenge) is high.

This reasoning is consistent with the results of Lakhani and Jeppesen (2007) that define the Innocentive mechanism as broadcasting search, and therefore mostly directed at finding new uses for existing solutions, rendering $cost_i(s_i) \simeq 0$. Although innovations result from a diversity of sources and mechanisms, a prevalent and very well-known mechanism is idea recombination (Schumpeter, 1911; Hargadon, 2003). Idea recombination is a result of

interaction and many platforms explore this possibility. However, broadcasting search reduces the likelihood of this possibility by rendering solutions proposed by solvers in an entirely private manner. Hence, by dissuading recombination, it does not fully exploit the innovation potential of the community.

> **Proposition 2.** The broadcasting search mechanism is a dis-incentive to the recombination of ideas.

3.6.2 Brainstorming with ranking

As it was discussed previously, Atizo, Opeanidea and similar intermediaries offer a platform that ranges from brainstorming to concept development, focusing on collaboration as the driving force. For this mechanism this research will focus on the role of collaboration in idea generation through brainstorming, commenting and ranking of ideas.

Mechanism: Brainstorming with ranking

Input: challenges $c \in C$ - *challenges proposed by seekers*
payments $p \in P$ - *payments rewarding solvers*
solvers $a \in A$ - *agents addressing the challenges*

Output: ranked solutions $s \in S$ - *proposed solutions*
comments $m_s \in M$ - *comments on solutions*

Mechanism: *Brainstorming with ranking:* $(c, p, a) \rightarrow (s, m)$

repeat

for each $c \in C$

$s_i \leftarrow$ ideas(a_i) - *agents propose solutions*

$m_s \leftarrow$ comments(a_i) - *contribute with comments*

$s_{ranked} \leftarrow rank(a, s)$ - *agents rank solutions*

return s_{ranked}, m - *set of ranked solutions and comments*

end

It is easily seen that it is not in the best interest of the agents to rank high or provide useful comments to the ideas of competitors. Therefore, the brainstorming with ranking mechanism is not incentive compatible.

Propositions 1 and 2, equally apply to the brainstorming with ranking mechanism.

Given a solution s_i provided by agent i and a solution s_j provided by agent j, if $r(s_j) < r(s_i)$ the opportunities of agent i are maximized, therefore it is in the best interest of agent i to rank lowly the competing ideas of agent j. It is obvious that it is not in the best interest of the agents to rank high or provide useful comments for the ideas of competitors.

> **Proposition 3.** Brainstorming with ranking mechanism takes advantage of recombination.

By keeping ideas public and encouraging comments, brainstorming with ranking tries to take advantage of cross-fertilization and recombination of ideas. A network is called a collaborative network if the members share their resources (and in this case their knowledge) through comments. In a Nash equilibrium game, players affect each others' utility and their feasible strategy sets through their own decisions. This can be represented as a cooperative Nash equilibrium game with n players and the strategy as S_i where $i \in \{1,2,\dots,n\}$. By definition, a Nash equilibrium point is defined as a point $S^* = \{S_1^*, S_2^*, \dots, S_n^*\}$, with the following condition hold, $u_i(S_i, S_{-i}) \leq u_i(S^*), \forall i \in \{1,2,\dots,n\}, S_i \neq S_i^*$. Therefore the utility function of an agent is higher if he collaborates with others. Therefore the utility function of agent is higher if he/she collaborates with others. However in the case of brainstorming with ranking mechanism the utility function of agent is lower when he/she collaborates. Despite this fact, members act irrationally and collaborate with each other. This might be due to other nonmonetary motives and affiliation. The existing number of comments also provides an empirical evidence for their action.

3.6.3 License out

License-out platforms offer a unique mechanism for trading patents, innovative products, and technologies. However, only a number of open innovation intermediaries provide such a service, and then mostly as a complementary service. Intermediaries such as Yet2.com provide an environment for companies and individuals to create a call for proposals of ideas, technologies, and products for a licensing-out agreement.

Mechanism: License out

Input: call for proposals $c \in C$ - *proposals (idea, technology, product) of companies & people*

payments $p \in P$ - *payments for proposals*

agents $a \in A$ - agents (companies and people) addressing *the proposals*

Output: deal $d \in D$ - *License out agreement*

Mechanism: *License out :* $(c, p, a) \rightarrow d$

repeat

for each $c \in C$

$d_i \leftarrow pro(a_i)$ - *agents propose patents, products, technologies*

return d - *License out agreement*

end

Both a seller and a buyer value an item for trade. However it is not in the best interest of an agent (seller) i with a proposal of patents, products or technologies d_i and a valuation $v_i(d)$ to trade if the valuation of buyer $v_j(d)$ is lower than the valuation of seller $v_i(d)$. In the case of no-trade, there will be no payment. The mechanism subsidizes the trade if $v_j(d_j) > v_i(d_i)$ and so it is in the best interest of j to reveal $v_j(d)$ instead of $v_j'(d)$ so it is incentive compatible.

3.6.4 Connect/ networking

A number of companies such as dotOpen, Communispace, and Inpama offer a platform that builds communities and networks of interest. This creates and requires a different mechanism.

Mechanism: Connect/networking

Input: call for networking $c \in C$ - *companies connect with clients, investors, etc.*
agents $a \in A$ - *agents*
Output: deal $d \in D$ - *new connections*

Mechanism: *Connect/networking:* $(c, a) \rightarrow d$
repeat
for each $c \in C$
$d_i \leftarrow pro(a_i)$ - *agents connect*
return d - *new connections*
end

The maximization of the objective function in a connection and networking mechanism depends on the number, expertise, and diversity of the participant agents in building new connections. In a communication network $G = (V, E)$, where each link $e \in E$ is owned by a different agent, the maximization of the objective function means finding the shortest path to a link with the right agent. Agent i receives a zero value if the link does not build an ecosystem based on what the agents are looking for. Thus it is in the best interest of the agents to reveal their true intentions and solutions to discover potential clients, competitors, suppliers, etc.

3.6.5 Expert groups

Intermediaries like Ninesigma provide expert group service that has a similar mechanism of broadcasting search. Here the main difference is that a group of experts is pre-selected prior to the challenge.

Mechanism: Expert groups

Input: challenges $c \in C$ - *challenges proposed by seekers*
payments $p \in P$ - *payments based on the completion of the task to experts*
experts $a \in A$ - *pre-selected agents addressing the challenges*

Output: solutions $s \in S$ - *proposed solutions*

Mechanism: *Expert Groups :* $(c, p, e) \rightarrow s$

repeat

for each $c \in C$

$s_i \leftarrow pro(a_i)$ - *experts propose*

return s - *set of solutions developed by experts*

end

Similarly to the broadcasting search, it is in the best interest of agent i to reveal s_i instead of s_i' to receive a payment.

3.7 Discussion

It was observed that there is a clear difference in intermediary services; either they provide services to find potentially relevant partners or identify specific solutions with or without their corresponding implementation. Therefore it is important to understand the objective and outcome of their services so that companies and people can utilize them appropriately.

Two main axes also stand out from the previous analysis: the management of monetary incentives and the need for collaboration. Monetary incentives look like the obvious choice for providing an adequate reward to solvers in exchange for their contribution. Monetary incentives also initially appear to fit with the need for spurring and fostering competition among solvers and creating awareness around the proposed challenge. These are probably the reasons behind the fact that all open innovation intermediaries that aim for a specific result for a product or service use monetary rewards and more tangible prizes as the main incentive.

There is, however, mounting evidence that this is probably not the most appropriate type of incentive when referring to innovation. Research has found evidence that direct incentives jeopardize exploration and result in works perceived as of lower quality (Carney, 1986; Getzels, 1976). Similar results were found in education (Deci, 2001) where the use of extrinsic incentives has always been extensive.

In the last decades large scale examples of group and user collaboration without monetary incentives have been witnessed. User generated contents such as Wikipedia, YouTube, and Open Source Software are prime examples. Particularly in the case of open source software a strand of research is also found around the motivation factors of the actors involved. The conclusions of this research point again in the same direction: the prevalence of intrinsic versus extrinsic motivators (Lakhani et al., 2005).

> ‘Collaborating with someone and receiving good feedback is as important as receiving a reward for their participations.’ CEO of Atizo

Concerning innovation in the business sector, some empirical evidence is found contradicts entrenched ideas that greater rewards lead to better performance. In fact, Ariely, Gneezy, Lowenstein and Mazar (2005) mentioned that in some contexts financial incentives can even

lead to negative performance. One of the more lucid conceptualizations of a theory that could explain this evidence comes from Teresa Amabile, who postulates that the level of creativity needed for completing a task is determinant when choosing motivators. Therefore, in algorithmic tasks (where the task steps are clear) extrinsic motivators will work effectively. By contrast, in heuristic (creative) tasks (where many possibilities must be explored), intrinsic motivators will perform better (Amabile, 1996a & 1996b). In her own words: 'Intrinsic motivation is conductive to creativity, extrinsic motivation is detrimental to creativity' (Amabile, 1996b, p. 119). However, in the case of open innovation intermediaries whose focus is to pursue and foster creativity and innovation in groups, it was witnessed how extrinsic and not intrinsic incentives, normally in the form of monetary prizes, play the main role (See Table 3.2). Based on our interviews and analysis, it was also observed that collaborative platforms present more intrinsic motives whereas non-collaborative platforms use more extrinsic motives for participation.

In addition, there is also another aspect where the type of extrinsic incentive used in the mechanism fails to align the preferences of the agents with the objectives of the platforms: namely, engaging a large number of agents. The Proposition 1 established that the mechanisms used by open innovation intermediaries rely on the availability and engagement of a large number of solvers among whom a solution for the challenge proposed either exists or could be developed. The main incentive for attracting these solvers is, again, a prize, an extrinsic motivator. However, when examining the existing literature on incentives for engaging crowds it was again found that extrinsic motivators do not work as expected and can produce disengagement (Mellström et al., 2008). This observation holds for both the broadcasting search and brainstorming with ranking mechanisms.

The intimate relationship between innovation and collaboration is widely accepted. Recombining ideas has been portrayed as a key mechanism by many authors since Schumpeter (1914), either in the form of hybriddation (Hargadon, 2003), or as cumulative innovation (Scotchmer, 2004). In the review of Proposition 2, it was established that where broadcasting search prevents recombination, brainstorming with ranking takes advantage of recombination. Therefore, there is a tension in the mechanisms between monetary incentives and benefiting from collaboration.

This tension is clearly evident when the mechanisms are analyzed through the lens of mechanism design. In the previous section this conflict is described and established that while broadcasting search, expert groups, License-out, and connect/networking are incentive-compatible, brainstorming with ranking is not compatible (See Table 3). Therefore incentives fail to encourage collaboration and this enables agents to gain by misrepresenting their contributions and preferences and lying about their true valuations. Thus intermediaries cannot use a platform at its full potential without recombining ideas.

> **Proposition 4.** Mechanisms employed by open innovation intermediaries in their platforms rely on incentives that: a) hamper creativity and innovation; and b) fail to incentivize when collaboration is introduced.

Name of mechanism	Incentive-compatibility
Broadcasting search	✓
Brainstorming (with ranking)	✘
License out	✓
Connect/ networking	✓
Expert groups	✓

Table 3.3: Incentive-compatibility of the five mechanisms

There is a second duality in the mechanisms presented that is worth examining, the duality between autonomy and collaboration. It was established that broadcasting search is a disincentive to recombination while brainstorming with ranking takes advantage of recombination. There is however, a lack of implementations that enables a smooth transition between these two extremes and mechanisms tend to lean towards one of the extremes.

There are clear benefits of collaboration in terms of enabling and fostering recombination. However, the importance of autonomy is probably not so obvious. There is, however, plenty of recent evidence on the link between autonomy and innovation. An empirical validation of these insights came from the work of Baard, Deci and Ryan (2004) in a study that covered a

large segment of business and corroborated this link between employee autonomy and business performance.

However, at the same time descriptions can be found among the best practices of how self-organized teams emerge from autonomy, producing better and often unexpected results. The importance and emergence of self-organized teams has been studied by Parker, Wall, and Jackson (1997). Also, in line with our discussion in the previous proposition, intrinsic motivation leads to better teams (Gagné & Deci, 2005). However, insights on how to take advantage of these two apparently opposite practices came only recently. Girotra, Terwiesch, and Ulrich in a recent paper (2010) examined the effectiveness of traditional brainstorming against what they called a hybrid structure, in which individuals first worked independently and then together. They found the hybrid approach notably superior in both the quality of the best ideas developed and their screening.

> **Proposition 5.** Generally mechanisms used by open innovation intermediaries either favor autonomy or collaboration exclusively.

A failure to establish ways to take advantage of both forms simultaneously can limit the efficacy of the intermediary, given the evidence that a mixed approach produces superior results.

3.8 Conclusions

Research has demonstrated a clear evolution towards increasingly mature models of intermediation. This evolution can be easily observed in contrasting the older and younger players in their relative sophistication in innovation intermediation. Our analysis has identified a number of findings related to the structure and consequences of different innovation intermediary mechanisms. Table 3.4 summarizes the findings of this research.

Research questions	Findings
What are some main archetypes of open innovation intermediary mechanisms?	Five main archetypes: 1) broadcasting search (directed and undirected); 2) brainstorming with ranking (directed and undirected); 3) networking/connect; 4) expert group; and 5) License-out
Which specific processes are supported by these mechanisms?	• Use of monetary and other incentives/motives •Use of large number of agents or expert groups •Use of ranking system •Moderation (monitoring) by experts •Collaboration & recombination of ideas through comments
What are the underlying tensions, pitfalls and limitations of these mechanisms?	Tensions: •between the use of monetary incentives and other incentives, •between the use of recombination of ideas while remaining incentive-compatible and autonomous, •between using a small number of experts capable of solving well defined problems and large numbers of agents that excel at solving ill-defined unclear problems
What are the consequent managerial implications for the choice and use of open innovation intermediaries?	• No collaboration and monetary prizes in broadcasting search will probably hamper creativity and the discovery of new solutions •Brainstorming with ranking provides mode innovative solutions due to collaboration •Exploratory problems should opt for mechanisms that foster collaboration at the expense of incentive-compatibility. •Complex problems could be easily adapted by an expert group. •Firms have to choose, depending on the problem, which of two drawbacks (recombination and autonomy) associated with each approach is less significant in terms of producing the best outcome.

Table 3.4: Summary of findings

Our main finding suggests that each mechanism excels at addressing specific functions and outcomes. Broadcasting search excels at finding and then reusing existing solutions, or at finding novel and maybe unexpected uses for existing solutions. However, the seemingly small number of prizes involved, together with the absence of collaboration in the search process,

may limit the discovery of novel recombination and new social interpretations of existing technologies. A clear limitation to this mechanism is the need for a large and focused network of solvers to be able to cultivate sufficient critical mass and interest in the proposed challenge. However, this type of mechanism has very low entry barriers for solvers, offering them a genuine opportunity for making a difference and succeeding with their proposals.

Brainstorming with ranking, by contrast, seems to hold the promise of being able to develop new ideas, novel recombination, and creative social reinterpretations of existing technologies. Some of the shortcomings of this mechanism have been extensively discussed; especially when the group is small and the experts are highly aligned with the presenters of the new proposals. In this case, as in normal brainstorming, the success of brainstorming with ranking is linked to the capacity of the group to interpret and engage with the challenge. Small groups of experts are better suited to providing interdisciplinary solutions that lie within their range of expertise, while large groups may be expected to generate original and unexpected solutions.

There is, consequently, a tension between mechanisms that foster collaboration and thus idea recombination if diversity is great enough, and those that rely on developing autonomous solutions at the expense of collaboration. Firms have to choose, depending on the problem, which of these two trajectories is most appropriate for producing the desired outcome.

Highly exploratory/open problems (e.g. creating marketing concepts) that could benefit more from a diversity of viewpoints and divergent knowledge domains should opt for mechanisms that foster collaboration at the expense of incentive-compatibility. Alternatively, complex problems (e.g. solving a chemical formula) could benefit more from finding novel applications of existing solutions that are easily adapted by experts. Other problems that are well defined and understood may benefit more from maximizing the incentives for solvers by preserving incentive-compatibility – again at the expense of collaboration.

Understanding the primary mechanism behind each open innovation intermediary provides insights regarding their applicability and limitations when confronted with real-life challenges and user behavior.

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Chapter 4: Motives for participation in online open innovation platforms[10]

4.1 Abstract

The increasing need to compete in innovation, together with the prevalence of IT in our social and economic interactions, has led to greater globalization in innovation sourcing. One of the best examples of this is the growth of online open innovation (OI) intermediaries and crowdsourcing platforms as markets for innovation. Unlike the Open Source model, these platforms allow intrinsic and extrinsic motives to interact and motivate participants, a phenomenon scantly covered in extant research. Accordingly, a better understanding of

[10] This research is under review for a forthcoming issue of the IEEE Transactions on Engineering Management. An earlier version of this has been published as Danish Research Unit for Industrial Dynamics (DRUID) Working Paper and it was also presented in DRUID Summer Conference, Copenhagen 2011.

participants' motivations can guide the design and management of these open innovation platforms. Data were collected through interviews, as well as through a web-based survey of the Atizo community, an open innovation intermediary, and Nokia's IdeasProject community, a corporate initiative crowdsourcing platform. The latter was designed based on the Theory of Planned Behavior (TPB) though augmented to partition both extrinsic and intrinsic motivators. This study also reveals that the differences between two platforms but still platform participants are motivated by both intrinsic and extrinsic factors, though intrinsic rather than extrinsic motives predominate. Specifically, enjoyment and sense of self-worth are the underlying intrinsic motives. It was also observed that the impact of attitude is greater than norms on intention to participate in online open innovation challenges. Furthermore, a self-assessed participation model is not as accurate and correlates negatively with a real participation model.

4.2 Introduction

Open models of innovation widely suggested the usage of external sources for the innovation process. One way of the involvement of external sources is opening up the innovation process to online communities. Online innovation communities are used to exploit open innovation by providing companies a platform with which to access a loosely-knit community of innovators. These communities can assist companies to achieve novel and appropriate products and services that fit better with users' needs.

Online open innovation communities such as crowdsourcing and intermediary platforms have recently gained a significant amount of attention. This has only accelerated after the U.S. Government launched its Challenge.gov project to find innovative ideas, products and processes to resolve federal problems, increasing the public profile of these intermediaries. Apart from the growing attention from governments and practitioners, academia has also shown greater interest in open innovation platforms lately.

Online innovation communities can intervene at different stages of the innovation process such as idea generation, problem solving, or design of a product or service. This creates a

variety of platforms with an aim of innovation. These innovation platforms vary considerably in terms of the kinds of activities ranging from idea generation (e.g., Atizo) to coding (e.g., Topcoder) to complex/scientific problems (e.g., Ninesigma), and who is hosting the platform such as public, brand community or third party intermediary. Among these platforms, this paper focuses on two types of platforms and their communities, i.e., an idea generation intermediary (Atizo) and a crowdsourcing brand community (IdeasProject).

Crowdsourcing communities are a particular form of online communities. Crowdsourcing is defined as outsourcing a task to an undefined, generally large group of people, in an open call form (Howe, 2006). Examples of these communities are CrowdSpirit and CrowdSource. There are many company hosted crowdsourcing communities, such as IdeasProject and P&G Connect+Develop. Innovation intermediary on the other hand is defined as an organization that acts as an agent or broker in any aspect of the innovation process between two or more parties such as users and companies (Howells 1999, 2006; Antikainen et al., 2010). Innocentive and Ninesigma are some of the well known examples of these communities. It is important to note that the main difference between company hosted crowdsourcing communities and innovation intermediary communities is that the users involved in innovation intermediary communities usually are not the companies' customers or users as in company hosted crowdsourcing communities. Therefore, there is not a strong relationship between the users and the company (Antikainen et al., 2010) and this can create different motives to participate.

Despite a significant growth in the number of online open innovation communities, online innovation platforms usually face certain challenges, such as: a) how to attract more people to the platform; and b) what kind of motivations to support and develop to attract more people. The studies show that only a few online communities manage to retain their members (Butler, 2001; Wasko & Faraj, 2005). Similarly, organizations that are willing to use online innovation platforms face challenges such as which platform to choose. They normally choose the ones with the greatest number of members who, in theory, can provide better solutions in a shorter period of time. Personal beliefs and social norms influence people's behaviors. Thus, it is crucial for online innovation platforms to know which motivations encourage people to participate in their community.

The TPB model (Ajzen, 1991) has been commonly used to investigate the effect of beliefs, norms and perceived behavioral control on human behavior in various settings and academic disciplines. Due to its superior predictive power, this study uses the TPB model to research people's intentions.

Apart from the TPB model constructs, motives also impact the intention of people's behaviors. A vast number of studies, especially in Psychology, focus on the context of people's motivations behind their participation in such communities. In general, the literature on human motivations has distinguished between two types of motivation, intrinsic and extrinsic. Intrinsic motivation refers to doing something for the inherent satisfaction it provides rather than for some separable consequence. Intrinsic motivation includes fun, self-determination, competence, curiosity, interest, and task involvement (Amabile, 1993; Ryan & Deci, 2000). On the other hand, individuals who are extrinsically motivated engage in a given activity to achieve extrinsic rewards. These rewards include direct or indirect monetary compensation such as evaluations, money and recognition (Ryan & Deci, 2000; Antikainen & Väätäjä, 2008). Consequently, these two motives are used as the predictors of attitude in our TPB model.

The objective of this study is to explore the specific factors which motivate people, increasing or lessening their intention to participate in two types of online innovation communities, i.e., crowdsourcing communities and the communities of innovation intermediaries. Since intention to participate is likely to be influenced not only by personal motivation but also by contextual forces, a theoretical Theory of Planned Behavior (TPB) framework which is augmented with the inclusion of extrinsic and intrinsic motivators (Ajzen & Fishbein, 1980) was applied. Applying a comprehensive motivation analysis is particularly applicable in the online open innovation intermediary and the idea crowdsourcing contexts since these platforms are one of the few empirical phenomena where intrinsic and extrinsic motivators are both present in a substantial way. To apply this framework, data were collected through a survey completed by members of the Atizo community, an open innovation intermediary and Nokia's IdeasProject, a corporate initiative crowdsourcing platform.

The research questions addressed in this paper are: 1) what are the underlying motives behind participation in innovation intermediary and crowdsourcing communities?; 2) which

factors and motives have a greater impact on the intention to participate?; and 3) how can platforms improve their mechanisms in order to attract more participants?

From a theoretical perspective, identifying antecedents of user intention to participate and determining how they differ will expand the open innovation, TPB and intermediary literature. In addition to this academic interest, a better understanding of motivational processes within an intermediary might help assess the heterogeneity of participants' needs and decide how to react and increase user commitment. Thus, from a practical perspective, knowing which motives are important in the decision to participate can be used to improve the design of these platforms, as this is crucial for their continued success.

To address the research questions proposed, our paper adopts the following structure. First, the extant literature on online innovation communities is presented, specifically, research on open source software communities, open innovation intermediary communities, and crowdsourcing. We then describe the research site and methodologies used to explain peoples' involvement in open innovation intermediaries. A web-based questionnaire was developed based on TPB and completed by members of the Atizo and Nokia community. After describing this model and its results, the implications of the results were examined for our understanding of the motivational processes in open innovation platforms. Finally, this research compares the TPB model with real participation data to evaluate the accurateness of the self-assessed participation TPB model. Our paper concludes with an overall assessment of our findings and implications for the theory, design and management of open innovation intermediaries.

4.3 Literature Review

With the expansion of online communities, the factors affecting people's intention to participate have received greater attention from researchers (Kollock, 1999; Lakhani & Wolf, 2005; Bagozzi & Dholakia, 2006). In general, researchers categorized motivations as intrinsic and extrinsic (Krishnamurth 2006; Ke and Zhang 2009) and it has observed that users are motivated by monetary rewards and/or non-monetary rewards. However, there is no

complete consensus on the effects of intrinsic and extrinsic motivation on online communities (i.e., Wasko & Faraj, 2005; Borst & van den Ende, 2010).

Previous studies examining the underlying reasons why people participate in online communities are mainly based on open source communities (Hertel, Niedner & Herrmann, 2003; Kollock, 1999; Shah, 2006). Among these studies, Bagozzi and Dholakia (2006) specifically analyze the psychological and social factors that impact developers' decisions to participate in open source software platforms. Since open source software projects do not pay for participants' services, contributors' motivations do vary.

Studies on open source contributor motivations have mainly focused on certain matters such as individual motives, the firm and community participation impact on individual motives, and the relationship between motives and technical design (von Krogh & von Hippel, 2006). Open-source programmers mainly participate for a personal need for a certain kind of software, or for their own self-interest (Hars & Ou, 2002). They may also be motivated by external factors. Social motives and norms have been found to relate to individual levels of contribution in open source software projects (Bergquist & Ljungberg, 2001).

A large number of studies in open source literature have distinctively used two motives, intrinsic and extrinsic, to classify contributors' motivations (Hars & Ou, 2002; Lakhani & Wolf, 2005). Exploring this conjecture with empirical research, Lakhani and Wolf (2005), Hars and Ou (2002) and Hertel, Niedner and Herrmann (2003) analyze the characteristics of open source software (OSS) contributors and their motivations. Both Hertel, Niedner and Herrmann (2003) and Lakhani and Wolf (2005) have found that intrinsic motives are the most fundamental for programmers when deciding to participate in OSS projects. For instance, enjoyment-based intrinsic motivation is the strongest and most pervasive (Lakhani & Wolf, 2001; 2005).

Several studies have investigated crowdsourcing communities and there are only a few empirical studies up until now (Lakhani et. al., 2007; Poetz & Schreier, 2009). There are also a number of studies focusing on motivations. However, most of these studies were mainly based on secondary data (e.g., Yang, et al., 2008a; Yang, et al., 2008b), and they are mainly focused on extrinsic motivation rather than intrinsic (Zwass, 2010; Zheng et al., 2011). Therefore, most of these studies are unable to entirely reveal the participators' motivations.

Regarding the online innovation communities, there are also a number of studies analyzed the motivations for participation (Hars & Ou 2002; Kankanhalli et al. 2005; Bitzer et al., 2007; Ke & Zhang 2010). However, the majority of the research has focused on extrinsic motivations (Davis, 1989; Igbaria et al., 1995). For instance, Antikainen and Väätäjä (2008) emphasize that monetary rewards are the main motivational factor in online open innovation communities. On the contrary, some studies explore that members are not only motivated by monetary rewards but also through intrinsic motives. Antikainen, Mäkipää and Ahonen (2010) have determined that intrinsic rewards are as decisive as monetary rewards. Similarly, Antikainen and Väätäjä (2010) have found that open innovation intermediaries use both monetary and non-monetary rewards to attract participants. The study of Antikainen, Mäkipää and Ahonen (2010) has also revealed 16 motivating factors for innovation communities based on a literature study, but it does not distinguish what motivates members in a certain type of community. Therefore, it is critical to find the specific motives in different types of online communities.

As occurs with open source platforms, in the case of open innovation intermediaries and crowdsourcing, it is also reasonable to assume that users can have various types of motivations. This is why a social psychological model is required to explore these motivations and their relations to the intention to participate. To our knowledge, no systematic empirical research using a TPB model exists addressing the question of what the underlying reasons are for people to participate in open innovation intermediary and crowdsourcing communities and that also analyzes internal and social factors together with motives. There are a few empirical researches focusing on online communities (i.e., Lee et al., 2011; Hsu & Lin, 2008; Schaedel & Clement, 2010) and only one study used a TPB model (i.e., Becker et al., 2010) to examine motives in a newly established community. However none of them focus on two types of online well established communities at the same time.

Our study builds on a larger body of theoretical and empirical work concerning the underlying reasons for people to participate in online open innovation communities by examining two theories in relation to populations: the Theory of Planned Behavior and the psychological theory of motivations. This study also wants to explore how motivations vary in two types of online communities. With this research, this research aims to contribute to both open innovation and TPB literatures.

4.4 Conceptual model: Theory of planned behavior

This section discusses the definition, operationalizations and interrelationships of the factors in our conceptual model. It draws on the literature about online innovation communities, the Theory of Planned Behavior and open innovation to guide the development of our conceptual model. The unit of analysis is an online open innovation intermediary and its community members.

4.4.1 Model development

TPB definition

Psychology has various theories to predict human behavior. Among these, the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980) and its extension, the Theory of Planned Behavior (Ajzen, 1991), are the most commonly used in several research fields (Madden et al., 1992).

Both theories assume that people systematically use information and act rationally. Their main proposition is that an individual's behavior is determined by the individual's behavioral intention (BI), which provides the most accurate prediction of behavior (Fishbein & Ajzen, 1975). TRA and TPB have been used to explain individuals' use and adaption of IT (Liker & Sindi, 1997; Lu & Lin, 2003).

Although the Theory of Planned Behavior is an extension of TRA, TPB provides a better fit when studying the online open innovation intermediary context due to the explicative power of Perceived Behavioral Control (PBC) in predicting behavioral intention. As a predictor of behavior, PBC measures the actual behavioral control (Ajzen, 1991) and, in online innovation contexts, it is an essential measure since it involves sharing information between members that might affect their own organizations. In TPB, behavioral intention is a function of three factors: Attitude (A), Subjective Norms (SN) and Perceived Behavioral Control (PBC). The main difference between TPB and TRA is the fact that the former uses Perceived Behavioral Control as another factor of behavioral intention (Ajzen, 1991).

Attitude towards a behavior refers to the degree to which a person has a favorable or unfavorable attitude towards that behavior. Subjective Norms are defined as the degree to which an individual perceives a behavior to be a norm among the people who are important to him or her (Ajzen & Fishbein, 1975). Finally, perceived behavioral control refers to the degree of difficulty or ease in performing a given behavior (Ajzen, 1991). Thus, TPB attempts to determine the relationship between these constructs using confirmatory modeling techniques. The TPB model is augmented with intrinsic and extrinsic motives that are measured under the attitude construct. As Fishbein and Ajzen (1975) point out, constructs external to the TPB model are assumed to influence intentions only to the extent that they affect either attitudes or subjective norms. In this context, PBC is presumed to only affect actual behavior directly.

Figure 4.1 below depicts our research model. Note that the model deviates in two subtle ways from the standard TPB formulation: a) in recognizing that attitude inherently involves intrinsic and extrinsic rewards; and b) perceived behavioral control is posited to directly influence the intention to participate. It is therefore believed that this formulation fits best with the online open innovation platform context.

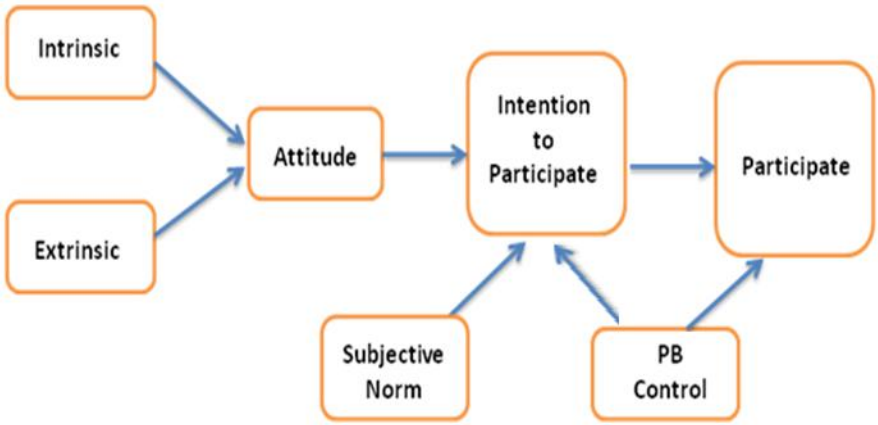

Figure 4.1: Research model

In this study, intention is referred to as an individual's willingness to participate in an online open innovation platform challenge. Thus, according to TPB, the stronger the intention, the more likely the individual will participate.

Attitude as an antecedent of intention is defined as the degree of an individual's favorableness towards participating in an online open innovation platform challenge (Ajzen & Fishbein, 1980). As a significant predictor of intention, subjective norms indicate the degree to which an individual perceives others participate in an open innovation community. Specifically, this research developed the extrinsic and intrinsic reward items based on the study by Amabile (1993) on intrinsic and extrinsic motivations. The set of constructs and their corresponding items are described in Table 1 in Appendix 2.

Hypotheses and measures

Since, as demonstrated, enhanced motivation promotes performance (Wilson, 2005), the question is whether this is the result of intrinsic motives, extrinsic motives or both. This is why intrinsic and extrinsic motivations have been analyzed by a number of studies in various contexts.

In Information Systems (IS) literature, the effect of intrinsic and extrinsic motivation factors on user acceptance has been analyzed in various studies (Deci, 1971; Moon & Kim, 2001). Moon and Kim (2001) have shown that intrinsic motivational factors have stronger effects on system usage than extrinsic motivational factors in the internet context. Contrary to Moon and Kim's findings, however, Teo, Lim, and Lai (1999) have found that extrinsic motivation has a stronger influence than intrinsic motivation. Specifically in the F/OSS community context, OSS member motivations were also analyzed based on internal factors and external rewards (Lakhani & Wolf, 2005; Hars & Ou, 2002). Contrary to previous findings on the negative impact of extrinsic rewards on intrinsic motivations (Deci, 1971; Lepper et al., 2005), Lakhani and Wolf (2005) have found that monetary rewards do not increase participation; nor do they find it has a significant negative impact on intrinsic motivations. These findings suggest a conflicting view. Likewise, Ebner, Leimeister, and Krcmar's (2009) study suggests that a mix of monetary and non-monetary rewards represents a successful stimulus for both intrinsically and extrinsically motivated participants in an online community environment.

Regarding online communities, innovation intermediaries and crowdsourcing communities are especially using monetary rewards for their contributing users. However, Antikainen, Makipa, and Ahonen (2010) suggest that intrinsic motives are more important since monetary rewards are not always the best way to motivate people according to their exploratory cases.

Even though there are both theoretical and empirical foundations for the analysis of intrinsic and extrinsic motivations, due to contradictory results in previous studies, the relationship between the two motivational factors and their interaction with the TPB construct such as attitude are still poorly understood. Accordingly, it is postulated that both intrinsic and extrinsic motives positively influence attitude, though intrinsic motives have a greater impact compared to extrinsic motives in online open innovation challenges.

> ***Hypothesis 1a.*** *Intrinsic motivations have a greater impact on the attitude towards the intention to participate in online open innovation challenges than extrinsic ones.*
>
> ***Hypothesis 1b.*** *The greater the intrinsic motives, the more favorable the attitude towards the intention to participate in online open innovation challenges.*
>
> ***Hypothesis 1c.*** *The greater the extrinsic motives, the more favorable the attitude towards the intention to participate in online open innovation challenges.*

The two central components of the TPB and TRA models, attitude and social norm, have compound effects on behavioral intentions (Ajzen & Fishbein, 1980; Ajzen, 1991). While most research has analyzed how attitude and subjective norms influence our intentions (Grube & Morgan, 1990; Terry et al., 2000), some studies have also examined the linear and nonlinear relationships that can exist between these two constructs in different contexts (Titah & Barki, 2009; Terry et al., 2000)

As Ajzen (1991) states, TRA assumes a complementary relationship between attitude (A) and subjective norm (SN) constructs, and these interaction effects are explicitly theorized in the TPB model. In the majority of studies, the linear effects of attitude and subjective norms on intentions and behaviors have described a positive interaction between attitude and subjective norms in a non-organizational context (Grube & Morgan, 1990; Terry et al., 2000).

Only a few authors mention a negative relationship between behavioral beliefs that produce an attitude and normative beliefs that result in subjective norms in corporate settings (Titah & Barki, 2009). Titah and Barki (2009) have found that when SN is high, increases in A have a decreasing marginal impact and vice versa. However, as the authors note, the contextual differences are important to take into account when examining the relations between attitude and subjective norms because relations vary depending on the contexts. Thus, it is important

to highlight and take into account the relationship between A and SN and their impact on intention which is different depending on the level of each construct.

A few studies in the IS context (Ajzen, 1991) have compared the influence of A versus SN on behavioral intention. For instance, Fusilier and Durlabhji (2005) suggest that highly positive attitudes are relatively unaffected by subjective norms. However, Kleijnen et al., (2004) show that the subjective norm construct is an important variable in the development of people's intentions. Still, most studies regard the weight of norms to be secondary to that of attitudes (Ajzen, 1991).

Due to the lack of a strong relationship between members in online open innovation communities and based on prior literature, it is hypothesized that subjective norms will not be as important as attitude in online open innovation challenges.

> ***Hypothesis 2.*** *Attitude has a greater impact on the intention to participate in online open innovation challenges than subjective norms.*

4.5 Research site and methodology

The aim of our research is to explore the main factors and motivations that can lessen or improve the intention to participate in online open innovation challenges. Given the novelty of the research problem, an explanatory study has been chosen as the research method. Focusing on Atizo and Nokia's IdeasProject, a quantitative study has been chosen to achieve an in-depth understanding of users' underlying motives behind their decision to participate in open innovation platforms.

4.5.1 Research site

Like other online open innovation intermediaries, Atizo consists of a web-based platform for intermediate companies to present their challenges and creative people to offer their ideas and solutions. Christian Hirsig, Atizo CEO, defines the company's business model as a media company whose corporate clients pay to publish their needs as challenges on the platform.

The community members then submit their ideas on line where other users can also see and make comments, thus eventually developing the initial idea collaboratively. After this online brainstorming phase, users vote on the ideas and companies finally pick the best ones among them and award the winners. This mechanism is what distinguishes Atizo from most innovation platforms such as Innocentive which use a system more like an idea drop box where users individually submit their ideas without any collaboration from others.

IdeasProject is an online community of Nokia for idea crowdsourcing. Like any other brand community, IdeasProject is a non-geographically bound community based on a structured set of social relationships among admirers of the brand (Muniz and O'Guinn, 2001). Similar to Atizo, IdeasProject enables the brainstorming of ideas between the users and developers while allowing communication between each other. Here members can create ideas, comment, review and build on other people's ideas. These ideas can evolve into real innovations and products eventually. Nokia run challenges and offers concrete rewards for the best ideas.

4.5.2 Data collection

To achieve our study's objectives, a variety of data was collected through a structured in-depth interview with Christian Hirsig, Atizo CEO, and Pia Erkinheimo, Head of Crowdsourcing at Nokia and through non-participant observations of the internet platforms and log files. To test the TPB model in this open innovation intermediary context, web-based surveys of the Atizo and Nokia community were conducted. The survey's initial version was refined through a pre-test with MBA students at an international business school. Personalized e-mails were then sent to each member, inviting them to participate in the survey. The Atizo survey generated 113 responses (15 females, 98 males; mean age = 41), representing a response rate of 18.3%. The subjects were mainly from Germany, Austria and Switzerland. Most of the participants were full-time employees or freelancers, and the rest were students. The Nokia survey generated 209 responses (98% males; mean age = 25), representing a response rate of 18.3%. The subjects were mainly from India, USA and Finland. Most of the participants (91.4%) were Nokia mobile phone user. Then hypotheses were examined by applying the partial least squares (PLS) method to the collected data.

The items were developed in the questionnaire by adapting the measures that had been validated by prior research (see Table 1 in Appendix 2). TPB measures include items that assess attitude, subjective norms, and perceived behavioral control of respondents' intention to participate in open innovation intermediaries. Items measuring perceived pressures were added in the TPB section. Metrics regarding intention, attitude, subjective norms, and perceived behavioral control were adopted and modified from Ajzen (1991) and Bock, Zmud, Kim and Lee (2005).

4.5.3 Research method

Once the data were collected on line, the partial least squares (PLS) structural equation analysis was applied to test the hypotheses. PLS is a structural equation modeling technique that assesses the reliability and validity of the measures of theoretical constructs while estimating the direct, indirect, and interaction relationships among these constructs (Wold, 1982). The PLS algorithm has become increasingly accepted and widely used in IS research (Urbach & Ahlemann, 2010). Frequently used in TPB, TRA models and motivation research, PLS employs a component-based approach for estimations to evaluate relationships within a structural equation model. The statistical program, SmartPLS (Chin, 1998; Ringle et al., 2010), was used to perform the structural modeling analysis. A large number of studies on the TPB validate the use of SEM. The research thus found using SEM with SmartPLS Version 2.0.M3 program in our analysis to be highly appropriate (Ringle et al., 2010). For the survey items, the research used a five-point Likert scale anchored at each end with the descriptors, "strongly disagree" and "strongly agree." For some items (to measure participation), a ten-point scale with options ranging from 1 to 10 was used.

4.6 Analysis of the structural equation model

4.6.1 Measurement validation

Prior to estimating the structural models, the measurement model was assessed separately for each model with the full sample. To assess the validity of our measurement model, content validity and internal consistency were checked. Content validity between the items and the existing literature was determined by our interview with Atizo's CEO and Nokia's Head of Crowdsourcing and with a pre-test of the model. Additionally, backward translation was used to ensure consistency between the original English version of the instrument and the German version for Atizo.

The research analyzed the relationships between the latent constructs and their items with measurement models. The loadings of their respective constructs are presented in Table 1 (Appendix 2) in order to examine the adequacy of the measures. Even though Chin (1998) indicates that standardized loadings should be greater than 0.7 as a rule of thumb, it is not as rigid at early stages of scale development and a 0.5 loading is still acceptable (Hair et al., 1998). Appropriately loaded items do not indicate the reliability of the items as a whole. As such, it also calculated composite reliabilities and Cronbach's alpha. Composite reliabilities were included as a contrast to alpha since the latter does not assume tau equivalency among the measures (Fornell & Larcker, 1981). Composite reliabilities ranged from 0.73 to 0.93. Except for the subjective norm and extrinsic items, all values were above the benchmark value of .80. Even though the subjective norm Value is below the benchmark at 0.73 and extrinsic is at 0.75, it is acceptable albeit weak. The Cronbach's alpha values were also checked for the internal consistency of the instruments (see Table 4 and 5 in the Appendix 2). Internal consistencies of all variables were considered acceptable, ranging from 0.61 to 0.92 and representing tolerable reliability.

Convergent and discriminant validity were checked to assess the adequacy of the measurement models. Said validity holds under two circumstances: 1) when the PLS indicators load larger than cross-loadings; and 2) when the square root of each construct's average variance extracted (AVE) is higher than its correlation with other constructs (Chin, 1998). As

shown in Appendix 2, Table 2 and Table 3, all items loaded well for their respective factors, with much higher values than all the cross loadings for the reflective latent variables. As shown in Appendix 2, the square roots of all AVEs are above 0.50. Bootstrapping tests suggest that all the measures have adequate convergent and discriminant validity. With the analysis of the measurement model being satisfactory, it was then proceeded to analyze the structural model.

4.6.2 Structural model

The structural model analyzes the relationships among the various latent variables. The following steps were taken to estimate a series of structural models for the full sample. The approach used is consistent with previous research analyzing motivations in various contexts. Our main structural model, expanded to include intrinsic and extrinsic motives, also incorporated the effects of subjective norms, attitude and perceived behavior on the intention to participate.

Initially, two separate models of motivations: a simple model and a TPB model for Atizo were run (see Figures 4.2 and 4.3 below). Each model solely focuses on the effects of constructs and motivations on participation. The PLS Algorithm and bootstrapping results are presented in Table 6 and 7 in the Appendix 2.

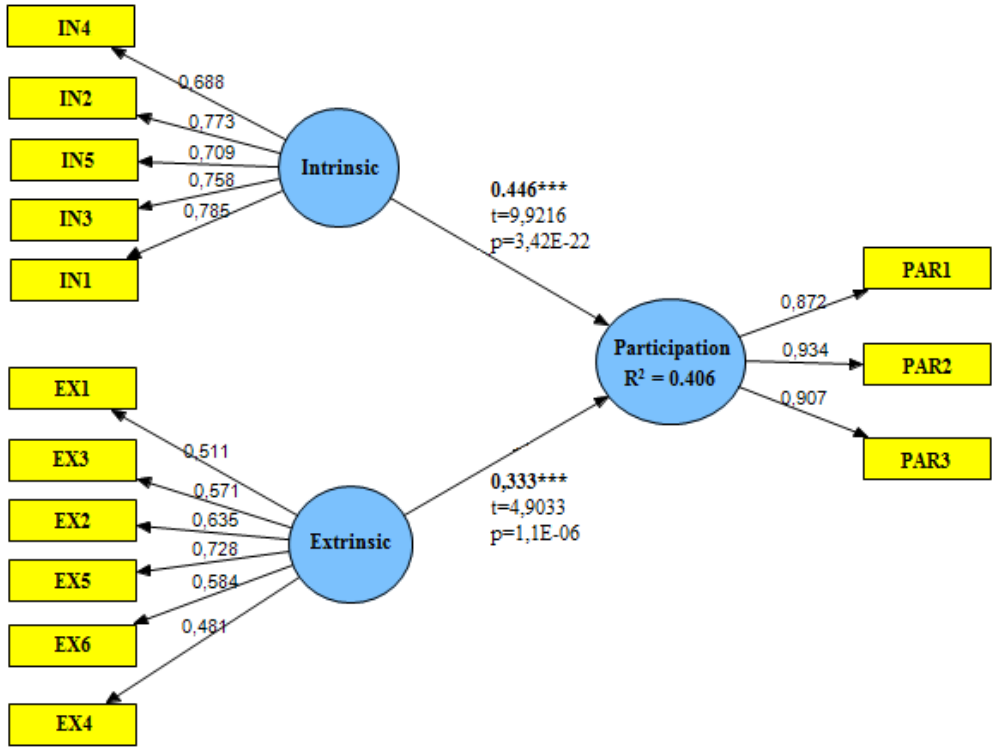

Figure 4.2: Model 1 - Atizo simple model based on self-assessed participation

To evaluate the predictive power of our structural models, the R squared (R2) values were checked that indicate the amount of variance explained by the exogenous variables (Barclay et al., 1995). Based on the results of the PLS Algorithm technique, the R2 values reflect the respective amounts of variance explained by the full model. The results based on the structural equation modeling of the models are depicted in Figures 4.2 and 4.3. The latter detail the factor loadings and R-square values as a PLS result directly in the path model. Quality indicators for both Model 1 (Atizo simple self-assessed model) and Model 2 (Atizo TPB self-assessed) represent a well explained model with an R2 of 0.406 and 0.293, respectively. The quality criteria and t-statistics are presented in Table 7 in Appendix 2.

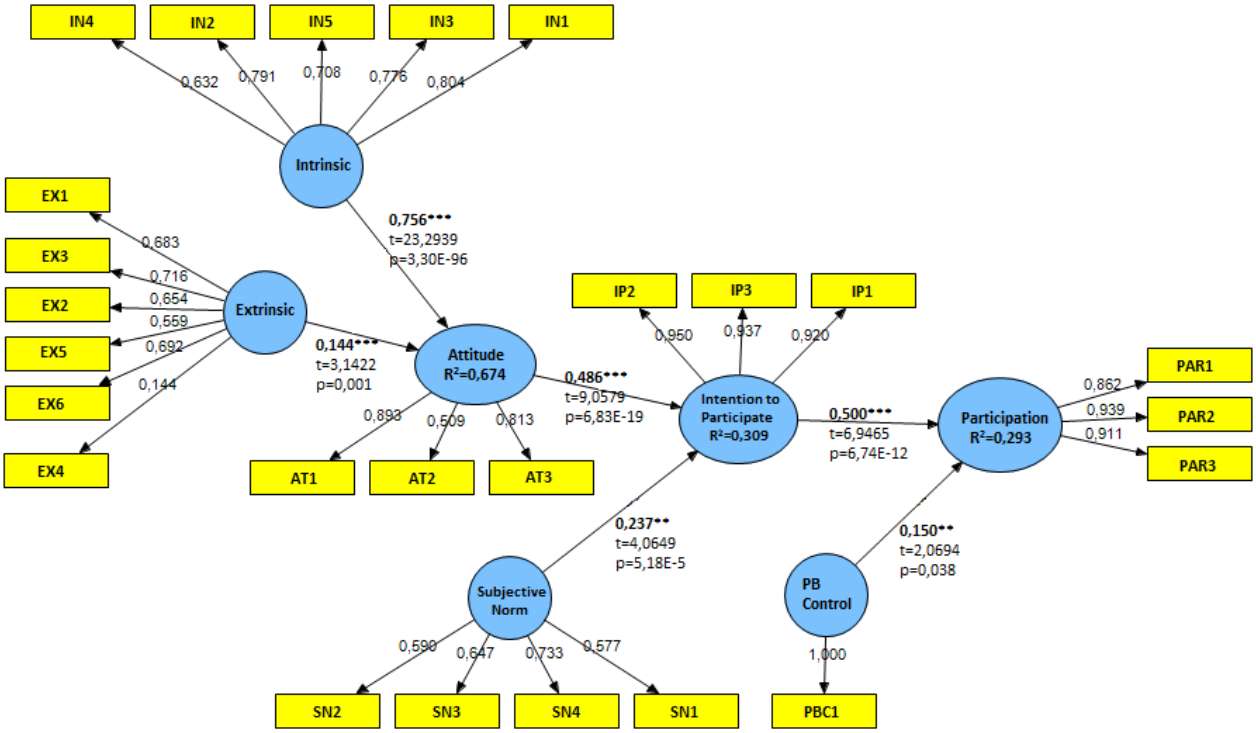

Figure 4.3: Model 2 – Atizo TBP for self-assessed participation

Using a bootstrapping technique, path estimates and t-statistics (two-tail) were calculated for hypothesized relationships. Our results suggest that the models are credible and that the factors subjective norms, attitude and perceived behavior control influence the intention to participate and that they have a significant effect on the decision to participate (see Table 6 and Table 7 in Appendix 2). The path in Model 1 (Atizo simple self-assessed model) is highly significant, with t-values of 9.921 (intrinsic) and 4.903 (extrinsic). This also holds true for the TPB model, with highly significant t-values at 23.293 (intrinsic) and 3.142 (extrinsic).

For Nokia, the research also run the same two models, a simple model and a TPB model (see Figures 4.4 and 4.5 below). Quality indicators for both Model 3 (Nokia simple self-assessed model) and Model 4 (Nokia TPB self-assessed) represent a well explained model with an R2 of 0.290 and 0.216, respectively. The loadings, quality criteria and t-statistics are presented in Table 7 in Appendix 2.

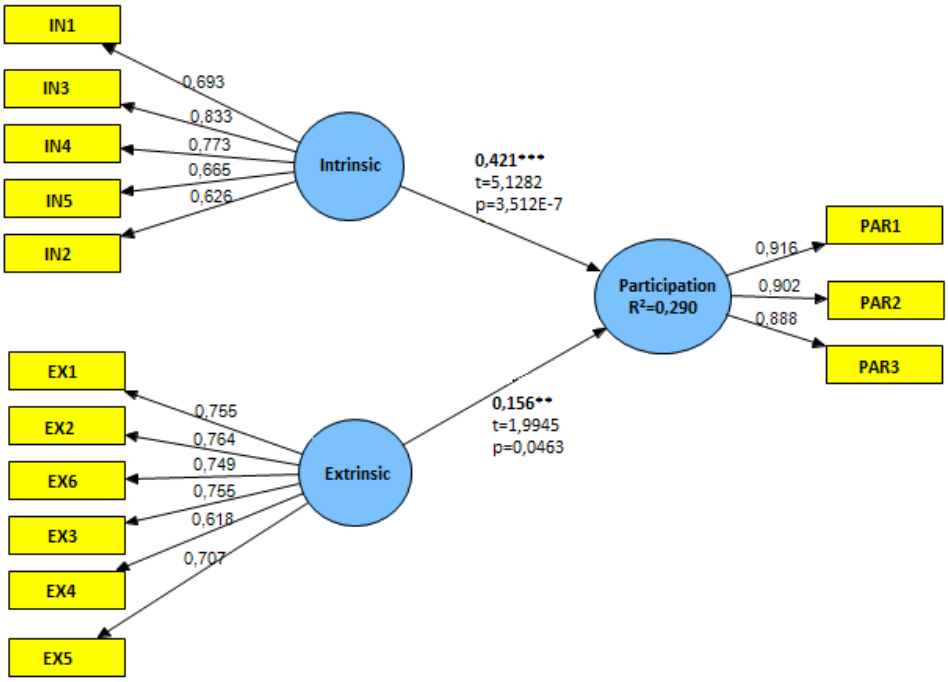

Figure 4.4: Model 3 –Nokia simple model based on self-assessed participation

Based on the bootstrapping results, the path in Model 3 (Nokia simple self-assessed model) is highly significant, with t-values of 5.128 (intrinsic) and 1.994 (extrinsic) (See Table C1 and C2). This also holds true for the TPB model of Nokia, with highly significant t-values at 11.3006 (intrinsic) and 3.472 (extrinsic).

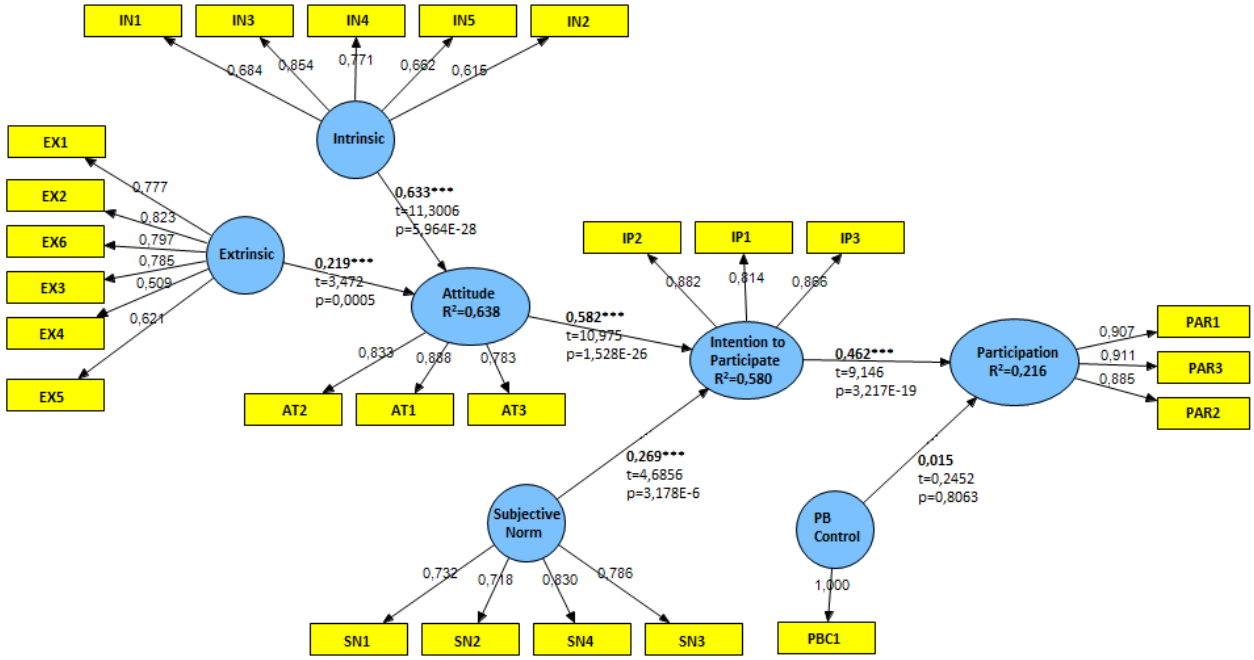

Figure 4.5: Model 4 – Nokia TBP for self-assessed participation

4.7 Results

The preceding section has served to analyze the factors affecting the intention to participate in online open innovation communities of Atizo and IdeasProject. With a satisfactory TPB measurement model and an acceptable level of multicollinearity, the proposed hypotheses were tested using Smart PLS. The results obtained with this measurement model support the reliability and validity of the instruments. Through our study of Atizo and IdeasProject, the main motives for participation in online open innovation intermediaries and idea crowdsourcing were revealed, motives which could be used to further improve the participation rate. The results of our hypothesis testing are depicted and summarized in 4.1 below.

Hypothesis	Remarks- Atizo	Remarks- Nokia
H1a: Intrinsic motivations have a greater impact on the attitude towards the intention to participate in online open innovation challenges than extrinsic ones.	Supported	Supported
H1b: The greater the intrinsic motives, the more favorable the attitude towards the intention to participate in online open innovation challenges.	Supported	Supported
H1c: The greater the extrinsic motives, the more favorable the attitude towards the intention to participate in online open innovation challenges.	Supported	Supported
H2: Attitude has a greater impact on the intention to participate in online open innovation challenges than subjective norms.	Supported	Supported

Table 4.1: Summary of hypothesis tests

Generally, it is expected that the extent of the effect of extrinsic motivations on participation would dominate over intrinsic motivations. However, in Model 2 (Atizo TPB self-assessed) and in Model 4 (Nokia TPB self-assessed) it was observed that this does not hold as much as expected in terms of participation.

Offering monetary rewards is certainly an important component of member motivation. Motivation to participate can be achieved by money, but long-lasting participation requires

more than just monetary rewards. Based on the results of the TPB self-assessed model of both Atizo and IdeasProject, both intrinsic and extrinsic motives have a positive correlation with attitude, but intrinsic motives (0.756 for Atizo, 0.633 for IdeasProject) dominate over extrinsic factors (0.144 for Atizo, 0.219 for IdeasProject). These results suggest that, in the online open innovation platform context, favorable individual attitudes towards participation are influenced by enjoyment motivators rather than by expectations of extrinsic rewards. Thus, H1a, H1b and H1c are supported for both Atizo and IdeasProject since attitude is more favorable as regards the greater intrinsic and extrinsic motives; however, intrinsic factors have a greater impact on attitude than extrinsic ones. In Atizo Model 2, sense of self-worth and fun are the two leading intrinsic motives with (0.80) and (0.79) loadings; enjoyment (0.77) personal development (0.63) has a lower impact. Even though in Nokia Model 4, enjoyment (0.85) and personal development (0.77) are the leading ones, still sense of self-worth has a positive impact with a loading of 0.68. Among extrinsic motives in Atizo Model 2, networking (0.71) and, to a lesser extent, recognition (0.69) and reputation (0.68) dominate monetary motives. Similarly in Nokia Model 4 visibility (0.82), recognition (0.79), and networking (0.78) are the leading ones whereas monetary motives have loadings of 0.50 and 0.62. Thus, respondents favor networking over all other types of reward mechanisms, even monetary rewards.

Finally, regarding TPB constructs, the results of Model 2 and Model 4 demonstrate that: a) *attitude* dominates over *subjective norms*; and, b) as *subjective norms* increase, people adopt a more positive *attitude* towards participation. When comparing the impact of attitude versus subjective norms, it was detected that attitude's marginal influence (0.486 for Atizo, 0.582 for IdeasProject) on the intention to participate is higher than the marginal influence of subjective norms (0.237 for Atizo, 0.269 for IdeasProject). Thus, these results support hypothesis 2 for both cases. It also observed that an increase in *attitude* while maintaining subjective norms constant produces a slightly higher intention effect than the opposite. In Atizo case, perceived behavioral control (0.150) is also found to correlate positively with the intention to participate in online open innovation challenges. This was insignificant in IdeasProject.

4.7.1 Extension – Controlling for self-assessment

Divergence between self-assessment and reality has been explored in various fields. For instance, psychological research has proposed that self-assessments about participants' actual behaviors, skills and performance are often flawed. This is due to the fact that people generally tend to overrate themselves, either because they do not have all the information they need (Rolfhus & Ackermani, 1999) or they have it but cannot maintain their objectivity and deny reality (Dunning et al., 2003). People also make overly optimistic assessments about their future behaviors and actions.

Most of the research in this field has found a weak correlation between self-assessments regarding knowledge, performance and skills compared to objective measures (DePaulo et al., 1997; Stajkovic & Luchins, 1998). For example, people's views of their own intelligence tend to correlate roughly 0.2 to 0.3 with their performance on intelligence tests and other academic tasks (Hansford & Hattie, 1982). Thus, the correlation between perception and reality in many domains is moderate to meager, and self-assessments may be flawed. To test this, it was further analyzed and compared the explicatory power of intention to participate of the self-assessed participation model with the real participation model.

Subsequently, two more models with real participation data were run, one simple and one TPB for Atizo case. For the two previous (self-assessed) models, survey results were used for the participation values, referred to as the self-assessed data. These two new models used the real data collected from Atizo's own log files to measure participation: the number of ideas provided, the number of projects completed, and the comments and ratings given (see Figures 4.6 and 4.7).

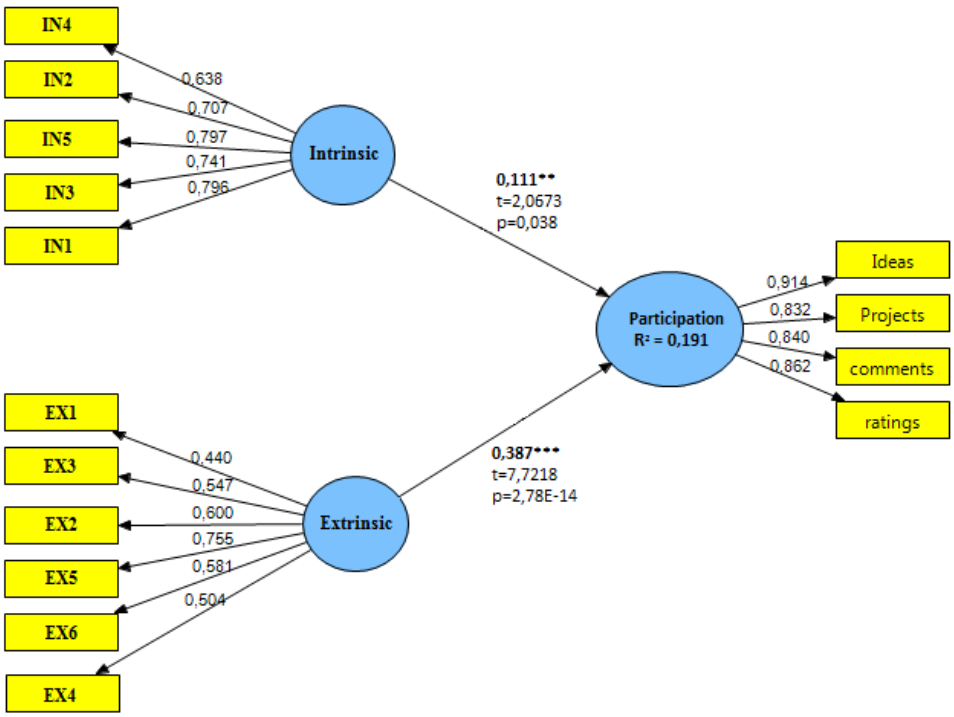

Figure 4.6: Model 5 – Atizo simple model based on real participation data

This gave us a chance to compare the difference between real and self-assessed participation. Since online open innovation intermediary platforms are a novel concept and environment, it is important to check whether factors and motives differ between the self-assessed and real models. Even though the path impact for participation differed statistically in the two models, the influence of the other constructs on the intention to participate was not distorted (see Table 1, Appendix 2).

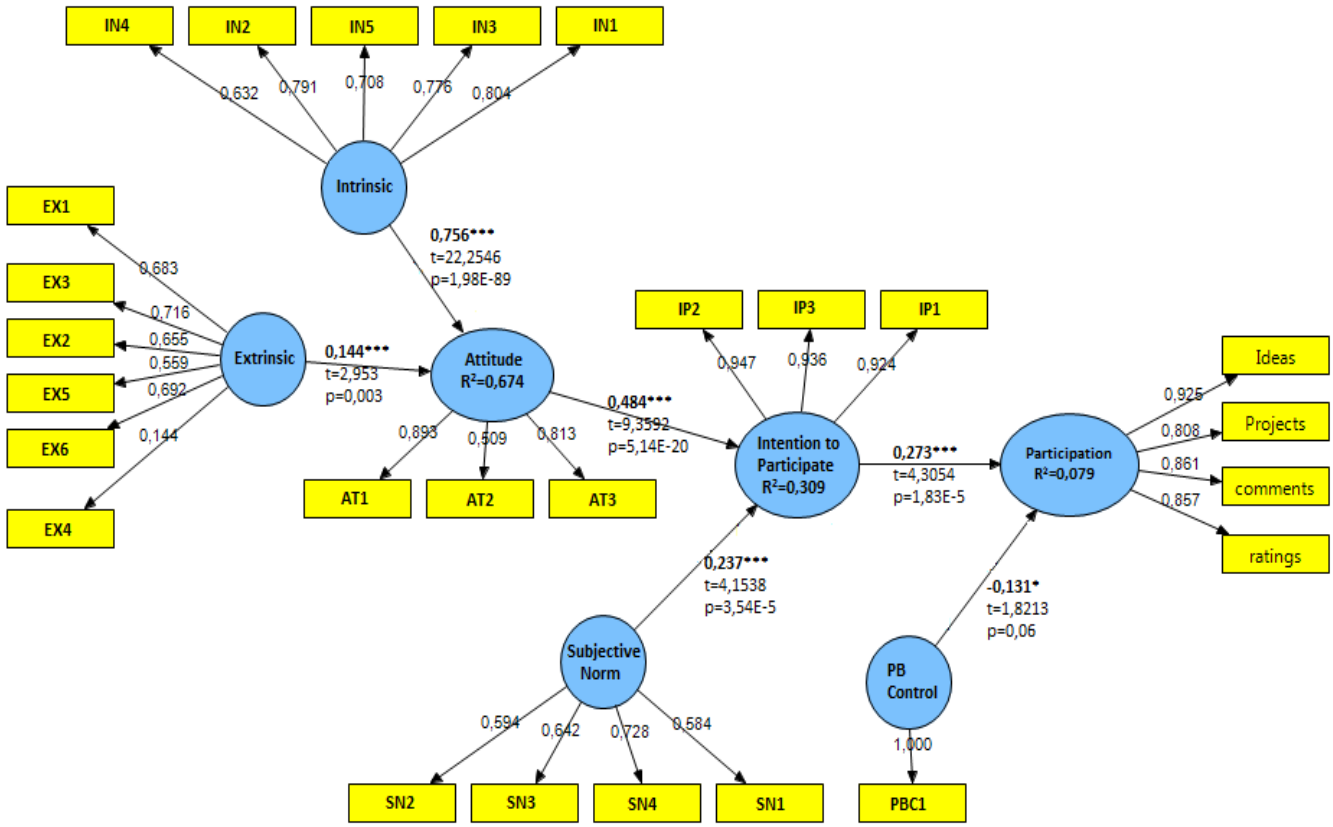

Figure 4.7: Model 6 –Atizo TBP for real participation data

The path of model significantly changes with real participation data in Model 5 (simple real model) to 2.067 (intrinsic) and 7.721 (extrinsic). However, when comparing the two TPB models, the t-values are roughly the same and highly significant.

Compared to the quality indicators in Model 1 (Atizo simple self-assessed model) which is R2 of 0.406, there is a significant drop in Model 5 (Atizo simple real model) to 0.191. A similar pattern occurs with the TPB models; Model 2 (Atizo TPB self-assessed) achieves a value of 0.292 for participation but drops to 0.079 in Model 6 (Atizo TPB real) with real data. Later the self-assessed participation model to real participation was compared (see Figures 4.3 and 4.4).

Based on the differences between the four models as depicted in Table 1 (Appendix 1), the loadings of intrinsic motives such as sense of self-worth and enjoyment increase while personal development and fun lowers when examining real participation data. Similarly, among the extrinsic motives, reputation's effect increases while recognition, networking, and visibility lower the intent to participate. The loadings of indicators measuring monetary

rewards had opposing changes. Compared to Model 1 (Atizo simple self-assessed), it was detected that extrinsic motives dominate over intrinsic motives in Model 5 (Atizo simple real). There is a clear divergence between real and self-assessed participation motives.

On the other hand, this divergence in motives is not the case in the TPB models. In both real and self-assessed TPB models, intrinsic factors dominate with the same loadings: 0.756. In fact, the loadings of all the constructs are relatively similar. Attitude translates into intention fairly well, and SN has a positive effect. However, PBC becomes a negative factor in the real TPB model. The intention to participate and the R2 of participation are lower in the real TPB model as well.

4.8 Discussion

The objective of this study has been to broaden the literature on intermediaries, crowdsourcing, TPB and open innovation. This paper has served to explore these online open innovation intermediaries and idea crowdsourcing platforms at an individual level in the TPB context. Accordingly, the research have: 1) revealed the underlying constructs and motivations encouraging users to participate in these platforms; and 2) examined the TPB constructs, their relations and how these impact on the intention to participate in online open innovation challenges.

The following findings have especially important implications and require further research.

- It should be noted that the comparative impact of attitude and subjective norm could vary in different contexts and environments. There are a number of possible reasons why subjective norms have less impact on intentions compared to attitude in our study. Firstly, this may be due to the absence of past experience such as shared norms in online environments. Secondly, geographical dispersion can also be expected to lead to differences in norms. Since internet is a diverse community, the lack of recognition or knowledge among participants may reduce the impact of these norms. Finally, people do not necessarily behave according to the same social norms in the real and virtual worlds. The impact of social norms

may also have different manifestations in these virtual worlds. These factors may possibly explain why attitude dominates over subjective norm in the online intermediary communities.

- Divergence between self-assessment and reality has been clearly observed in our results. This is also consistent with previous literature (Stajkovic & Luchins, 1998). This difference may be due to the fact that participants overrate their own participation and future commitment. Another reason could be the heterogeneity of the online community which it can be seen from the real participation data. This would indicate that certain groups in the community tend to participate more than others. This is due to the fact that people have different motives, a fact which would enable them to be grouped separately into homogenous clusters. As such, cluster analysis is required for further analyses of the TPB model in online communities.
- Apart from providing an additional scope for research on TPB, the analysis of the sense of self-worth may have another measurement benefit. Sense of self-worth can vary among different clusters and different types of participants. Evaluating the differences in motivation of each cluster could be an important means to achieve more accurate implications. Thus, further research is required to examine different groups' motives.
- The explicatory power of the TPB model is high when using self-assessed data. However, it was observed that the TPB model fails to explain real participation. Criticisms of studies using the Technology Acceptance Model TAM model have found that self-assessed data is a subjective measure and cannot be reliably compared to real, factual data (Legris et al., 2003). That notwithstanding, most TAM studies still employ self-assessed data.

Previous IS studies (specifically on open source software) and psychology literature have acknowledged the importance of enjoyment and sense of self-worth in representing intrinsic motivation and how intrinsic motivators influence individuals' acceptance and participation behavior (Venkatesh, 1999; Amin et al., 2007; Gecas, 1971). Some authors have concluded that enjoyment has a positive correlation with intention (Teo et al., 1999). For example, Deci,

Koestner and Ryan (1999) determine that enjoyment is positively correlated with expressed interest and problem-solving activities. Similarly, the sense of self-worth is closely tied to effective performance (Bandura, 1978). Mainly the reflected assessment with appropriate feedback contributes to the development of sense of self-worth (Gecas, 1971). The literature presents a congruent relation of self-worth with organizational norms (Huber 2001, Crocker et al., 1994), and attitude (Ferris et al., 2009; Gangadharbatla, 2008). Thus it is expected that sense of self-worth would lead the development of favorable attitudes toward participating in online communities. Contrary to these results, Amin et al., (2007) and Igbaria et al., (1995) do not find a relationship between enjoyment and intentions. Despite these conflicting results, one would expect that a certain level of enjoyment and sense of self-worth definitely influences the users' intention to participate. Future studies can also analyze how sense of self-worth and enjoyment affects the attitude towards the intention to participate in online open innovation challenges.

Based on the reinforcement theory of motivation, an individual's behaviors such as work performance or motivation are based on the consequences of other factors such as payment. Thus, the use of monetary incentives to encourage motivation is derived from reinforcement theory (Skinner, 1969). Some studies have argued that monetary rewards have a constructive impact on motivation and innovativeness (Eisenberger, 1999; Laursen & Foss, 2003). Alternatively, some researchers have criticized that monetary rewards can eliminate or reduce intrinsic motivations for a task (Deci, 1971; Amabile, 1993). This would also weaken people's proactive innovativeness and creativity, especially in the case of exploratory tasks (Amabile, 1993). However, most of these studies are based mainly on lab environments, and there is no general consensus about intrinsic motivators being overridden by monetary rewards. For example, various studies have analyzed worker motivation in labs, generally concluding that monetary rewards are the main motivators (Srivastava et al., 2001; Diener & Biswas-Diener, 2002; Perry et al., 2006). However, these studies have also detected that employees are not exclusively motivated by monetary compensations and that these do not always lead to superior performance. Perry, Mesch and Paarlberg (2006) suggest that, while financial incentives improve performance, their effectiveness still depends on the context. Thus, differences in institutional conditions have an impact on the effectiveness of monetary

incentives, especially in service organizations. Thus, it would be interesting to assess the impact of monetary rewards on the attitude compared to visibility and reputation.

Our research has key implications for practitioners as well. Online platforms are interested in how to attract and keep more people participating in their online open innovation communities. With more people, they could attract more organizations to use their platforms. Organizations are interested in attaining the best results in a short time period. Thus, the number of participants and their engagement is crucial for platforms. Based on our results, it can demonstrate that intrinsic motivations such as sense of self-worth and enjoyment are crucial to attract participants. This can be accomplished by creating an intermediary mechanism that supports these specific motives. Based on our interview, it is believed that there should also be active support for collaboration and networking among members when resolving corporate challenges in online platforms. This research thus emphasizes that extrinsic rewards such as money are not necessarily the primary motive behind participation, possibly requiring the development of other support mechanisms for other motives.

As a result, a number of future research directions can be extracted from the results of this study. As mentioned, the generalizability of these findings to other intermediary platforms, particularly larger and international ones, needs to be studied for the robustness of the findings. Another key direction for future research is to further understand dimensions such as affiliation and networking and how changes in the levels of external pressures can impact intentions. Also, cluster analysis is required to create homogenous groups and further analyze the TPB model and determine its validity.

4.9 Conclusions

Neoclassical economics portrays individuals as utility maximizers with a given set of preferences (Smelser & Swedberg, 1994). However, the importance of behavioral aspects and social effects has been increasingly stressed. This study has attempted to explore behavioral aspects when elucidating the motives and intentions for participation in online open

innovation intermediary communities and their corporate challenges. This study represents a novel contribution to the literature, providing an opening towards a holistic understanding and dissemination of the Open Innovation concept.

Two main constructs in our models aim to capture these aspects: attitude and subjective norms. Extrinsic rewards are a mere component in our model and not precisely the most important one. It can be observed how intrinsic rewards and networking affect the intention to participate in a more pronounced way than monetary rewards. This contrasts sharply with the established incentives in most platforms available today and the lack of elements allowing the expression and development of what constitute the main motivators according to our model.

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Chapter 5: Conclusions, implications, and future research

5.1 Conclusions

This chapter summarizes the work presented in this dissertation and discusses its implications for management and public policy. It also highlights the main contribution of this thesis for the strands of open innovation and intermediaries. The thesis concludes by acknowledging some of the main limitations of this research and proposes areas for further research.

5.1.1 Review of dissertation

Open innovation refers to opening the boundaries of organizations that are actively involved in intellectual property trade (i.e. ideas, technologies). Open innovation transforms the private sector as well as regional innovation systems. Prior literature on open innovation intermediaries has shown that open innovation intermediaries matter and are used as a tool

in the innovation process. Only a very limited research has examined the underlying mechanisms of these intermediaries, the motivations of individuals participating in these platforms, and the possible presence of similar intermediaries in the public sector.

This dissertation throws light on this issue by examining three fundamental questions: (1) Do open innovation intermediaries exist in local governments and the public sector, and if so, what are their main roles? (2) What are the underlying mechanisms of open innovation intermediaries?, and (3) What are the motives for participation in on-line open innovation platforms?

This thesis is composed of a compendium of three research articles.

Chapter 1 gives an introduction to the thesis and outlines its structure while providing a theoretical background and defining the research gap.

Chapter 2 analyses the presence of open innovation intermediaries in city innovation systems and their role in these systems. A multiple case study across Europe reveals the increasingly important role of open innovation intermediaries in public innovation systems. The objective of the public sector is to find novel solutions while building ecosystems by connecting and engaging communities. This is why city halls and local government need public open innovation (POI) intermediaries to solve challenges while building and sustaining networks. This research addressed the following research questions: 1) How do public and private agencies function as POI intermediaries? 2) How do local governments manage these intermediaries and the information flow? 3) What are the main benefits and obstacles encountered by local governments and public intermediaries? 4) What kind of policy implications can be derived? It was found that POI intermediaries maintain active networks with various constituencies by means of facilitating their participation in the innovation ecosystem of cities while bridging the considerable cognitive distance between city halls and innovative communities, and thereby facilitating knowledge recombination and the co-development of novel solutions. POI intermediaries also create value by orchestrating the collaboration of actors and communities in cities through innovation projects. Thus these findings provide several implications for policy makers for sustaining the competitiveness of cities in the knowledge economy of the next decade.

Chapter 3 takes the question into private sector and starts with a comprehensive review of the literature that identifies a research gap, namely, the underlying mechanisms currently employed by online open innovation intermediaries. The specific research questions are the following: 1) What are some main archetypes of open innovation intermediary mechanisms? 2) What specific processes are supported by these mechanisms? 3) What are the underlying tensions, pitfalls, and limitations of these mechanisms? and 4) What are the implications? This chapter initially provides a typology based on the intermediary services provided and establishes two main axes: 1) collaboration or no collaboration, and 2) building connections by identifying concrete solutions. Open innovation intermediaries are subsequently approached from the point of view of algorithmic mechanism design and the limitations of each type of intermediary are explored. The research found that mechanisms employed by open innovation intermediaries mainly rely on monetary incentives and this approach hampers creativity and innovation. It is also observed that mechanisms generally favor either autonomy or collaboration, and some fail in being incentive-compatible as soon as collaboration is introduced.

Looking more closely at open innovation intermediaries, a perplexing behavior was observed: individuals share knowledge and intellectual property online in return for possibly small rewards. To analyze the underlying reasons of this, Chapter 3 provides two examples of very successful open innovation platforms: Ideasproject (the corporate initiative idea crowdsourcing platform of Nokia) and Atizo (an open innovation intermediary).

The objective is to broaden the literature on intermediaries, the theory of planned behavior (TPB), and open innovation by exploring these online open innovation platforms at an individual level with PLS. The following specific research questions were introduced in this research: 1) What are the underlying motives behind participation in online open innovation communities? 2) Which factors and motives have a greater impact on the intention to participate? and 3) How can platforms improve their mechanisms to attract more participants? The main differences between both platforms were explored and it was found that participants of both platforms are motivated by intrinsic and extrinsic factors mutually. It was observed that intrinsic motivations have a greater impact than extrinsic motivations on attitudes towards the intention to participate in online open innovation challenges. In particular, enjoyment and a sense of self-worth are the main intrinsic motives. The impact of

attitude is greater than subjective norms, and lastly, the self-assessed participation model is not as accurate when used with a real participation model. Findings provide several implications that support, but also extend, what is known about open innovation platforms and the dimensions of successful utilization.

Chapter 5 contains a discussion of the thesis in general with main contributions, as well as policy and managerial implications. The chapter gives an overview that provides a summary of the other chapters and their contents. Lastly, limitations and future research are presented.

5.1.2 Contributions of this dissertation

This dissertation has made significant contributions in open innovation and intermediary strands of thoughts, as well as contributing to policy and practice. It has provided in-depth insights into the key characteristics and mechanisms affecting knowledge regeneration and innovation in both public and private sectors. This dissertation has built a foundation for future open innovation intermediaries and innovation policy research in different countries.

This study offers a number of methodological contributions. Firstly, our study is a first attempt to use an algorithmic mechanism design and TPB framework model to study the underlying mechanisms of open innovation intermediaries and the main factors shaping the intention to participate. Secondly, the partial least squares (PLS) method is a valuable application for studying motives of open innovation platform participators. It enables quantifying and characterizing the motives of people who participate in online open innovation platforms. Previously, PLS regression modeling was used in research on marketing and strategic management. Our study is a first attempt to use PLS to study the antecedents of intention to participate in open innovation platforms. An additional contribution lies in the application of the TPB model that is augmented with intrinsic and extrinsic motives that are measured in an online open innovation context.

This thesis offers a number of theoretical contributions that have been discussed earlier in this thesis. These contributions can be summarized accordingly. The first theoretical contribution considers online open innovation intermediaries from the point of view of their platform mechanisms, developing some variables that are generalizable across mechanisms, and

revealing distinct mechanism archetypes – while deriving the tensions and limitations of each mechanism. Another key to theoretical contribution is provided with the analysis of motivations for participation in online open innovation platforms. The underlying constructs and motivations encouraging users to participate in online open innovation platforms are revealed. Through the analysis of open innovation intermediaries in public, this thesis also revealed the role of public open innovation intermediaries in the innovation ecosystem of city halls. Alongside these contributions, this thesis also contains a number of implications for managerial practice and policy makers.

5.1.3 Organizational and managerial implications

Besides the contribution of this work to research, implications are also suggested for practitioners and policy makers. In general, insights from this study indicate that if organizations want to derive the maximum benefit from open innovation intermediaries, then they should understand the underlying mechanisms of intermediaries. The research findings on mechanisms of online open innovation intermediaries can be used to help understand aspects of the organizational structure of these intermediaries, understand the objective and outcome of their services, and how to best benefit from and use these services. Managers are advised to choose open innovation intermediaries, depending on the problem, in function of which of two drawbacks (recombination and autonomy) associated with each approach is less significant for producing the best outcome. Complex and well defined problems can easily be adapted by an expert group while ill-defined exploratory problems require collaborative platforms at the expense of incentive compatibility. It is also important to note that autonomy and monetary prizes in broadcasting the search will hamper the discovery of creativity and innovation.

For practitioners, the research findings on motives for participating in online open innovation intermediaries is important for understanding how to attract and keep more people participating in online open innovation communities and eventually attract more organizations to the site. Managers of intermediaries are therefore advised to support intrinsic motivations such as a sense of self-worth and enjoyment which are crucial to attract greater participation. Managers should also actively support collaboration and networking

among members for resolving corporate challenges in online platforms. These can also be important measures to consider for organizations deciding with which intermediary to collaborate.

The findings from public open innovation intermediary research have important policy implications. First of all, the findings show that public open innovation intermediaries should exist and compete with each other. To achieve this, policy makers are therefore advised to increase available funding while engaging in more interaction at all levels. City halls should also assist and guide public intermediaries in creating various communities and building new networks and clusters to increase innovativeness and the growth of regional economies.

5.1.4 Limitations and suggestions for future research

This study is subject to several limitations and these create several future research directions. These limitations also suggest caution in generalizing research findings.

The mechanism design research can be extended in several ways. Firstly, the mechanism design method does not have to be limited to open innovation intermediaries. It could also be extended to the implementation of the mechanism design method in the context of crowdsourcing or open sourcing. Secondly, it would be useful to explore some extensions to the mechanism. For example, a comprehensive approach could be developed for modeling a participator's motivations and reputation. Thirdly, feedback mechanisms can be separately analyzed to provide an optimal design of feedback mechanisms from the trust-building literature perspective. The content analysis of comments can also be worthwhile in order to obtain an objective analysis of the contribution and credibility of the comments. Finally, the intermediaries in our sample either define themselves as open innovation intermediaries or they are defined by *openinnovators* (http://www.openinnovators.net/list-open-innovation-crowdsourcing-examples/). Future research could extend this list of open innovation intermediaries.

Firstly, there may be a selection bias in the analysis of motives because the data was obtained from only two online open innovation platforms. In any case, a prominent avenue for future research is to include several open innovation platforms, possibly from different mechanisms,

as identified in Chapter 2, and establish a comparison among them. Secondly, it is also observed that people have different motives, and so cluster analysis would create a better understanding of motives with the TPB model in online communities. For instance, a sense of self-worth can vary among different clusters and different types of participants, and so evaluating these differences in each cluster could help achieve more precise deductions. Finally, due to the limited number of cases, it would also be worthwhile analyzing the impact of affiliation and networking at different levels of external pressures and the overall impact on intentions to participate.

In public open innovation intermediary research, several limitations were observed that could also lead to several future research areas. Even though we are aware of the benefits of public open innovation intermediaries in the innovation system of city halls, the research does not explain the costs of utilizing them for city halls and organizations. Creating an understanding of under which conditions it would be a rewarding strategy to use these intermediaries will be an important aspect for future research. Secondly, even though the cases cover various European city halls and their collaborating intermediaries, the research does not involve any insights from the organizations that work for and alongside these public intermediaries. Thirdly, it would be interesting to analyze the level and media of collaboration of these intermediaries with city halls and other organizations. The main methodological limitation is generalizability, since the selected research method, case study, only enables generalization of the results for Europe. Also how city halls adopt new practices to cope with external sources of innovation is worth examining. Finally, the main opportunity for further research is in observing the impact of open innovation intermediaries from a longitudinal perspective by examining the success rate of these collaborations. This would provide an opportunity for running experiments and creating a better evaluation for factors affecting participation.

5.1.5 Critical reflection

Undertaking a doctoral research has been an incredible journey and a major commitment for me. Even though this Ph.D. was a well considered course of action, my research developed in many unexpected ways. This thesis was mainly shaped by the several research projects in

which I participated during my PhD studies. I have been very fortunate to have had the chance to work on projects that provided access to companies and the necessary data.

This part of the thesis aims to provide an overview of the nature and purpose of innovation intermediary research with the focus on the main research questions, and makes a case for a critical reflection on the research. This critical reflection will provide insights from individual experience that merge with theoretical learning processes during my PhD studies. Moreover, critical reflection is a valuable development activity and part of PhD studies.

For the critical reflection of the thesis, the following questions are mainly addressed:

- Does the thesis provide a good synthesis?
- Does the review shed light on any gaps in previous research?
- Are the data selection and methodologies appropriate?
- Does it show the relationship of each work to the other?
- Does the thesis show useful insights and contributions?

This thesis aims to shed some light on the acknowledgement of the mechanisms, their supporting factors, and their role in innovation ecosystems; while identifying several implications for actors in innovation ecosystems. The review of the literature initiated with open innovation and later with the selection of my PhD research topic, narrowed the focus on innovation intermediaries. The review gives an overview of the currents and debates in the field while discussing the major works. It also highlights the relatively under-researched nature of innovation intermediaries, given their increasingly extensive role. The overall review concluded that the effective development of innovation with intermediaries requires an understanding of mechanism design, motivations, and factors, as well as the context of innovation ecosystems. Studies in this area cannot treat innovation intermediaries as other innovation agencies or tools, and there is a need for in-depth research on various aspects.

The goal in Chapter 2 is to create a set of implications for an enhanced public innovation ecosystem. However, it also aims to increase comprehension by better understanding the dynamics at play in the public innovation ecosystem by analyzing the role innovation intermediaries with cross-case synthesis. After exploring the role of open innovation intermediaries in a public innovation ecosystem, it is worthwhile analyzing their roles in private sector.

Chapter 3 analyses online innovation intermediaries that have platforms for running innovation challenges for organizations. In this chapter, a theoretical approach is conducted to analyze the underlying mechanisms of innovation intermediaries and further evaluate their support structures in the following Chapter 4. This section identifies different types of innovation intermediaries through a typology, and then analyses these types based on mechanism design theory. In this chapter, the main question is what the main innovation intermediary mechanisms are and how the underlying pitfalls and limitations can be improved for a better performance. The following chapter is largely based upon the insights generated in Chapter 3, but is more empirically oriented.

In Chapter 4 a common type of intermediary is selected to further analyze and make comparisons with a crowdsourcing platform. The chapter investigates innovation intermediaries from a different, yet important, perspective. The individual level analysis is important to understand the compositions of individuals' intentions and their reasons for participation. Using the TPB model and taking into account other motivational factors, this chapter concludes that motivations are likely to affect people's attitude to participation in online innovation challenges. This is an approach that attempts to reveal the motivations of the participators in order to gain a better understanding of the complex set of factors and influences that result in an innovation challenge and ultimately increase the performance of innovation intermediaries.

All chapters end with a discussion of the major findings and suggestions of improvements for innovation intermediaries and for the organizations how to utilize these intermediaries.

As can be seen in the descriptions of chapters, the undertaken work has not always been as structured and linear as its eventual outcome in the form of this dissertation. Therefore, a couple of remarks on the research process need to be made.

The nature and performance of the innovation intermediaries is a highly contestable and novel subject. Using cases from public and private sectors, this thesis identifies the major roles of innovation intermediaries and provides implications to improve their performance. Each chapter aims to dispel a myth and enhance our understandings about innovation intermediaries.

One of the main obstacles in investigating innovation intermediaries is finding the appropriate datasets. Initial data collection to build the literature review involved conversations, journal articles, books, and websites. Further data is collected with surveys and critical in-depth interviews for analysis.

The problem of the lack of access to quantitative data is faced in public sector analysis of innovation intermediaries. In Chapter 2, a convenient sample was found by accessing intermediaries with a European Union project. It is important to note that innovation intermediaries in the European public sector may be different from innovation intermediaries in other public sectors worldwide. Hence, the findings should be interpreted cautiously when generalizing to other environments.

For the remaining chapters, there is also room for enhancing sample size. Another avenue for future research may be including other innovation intermediary types and comparing them. Also, since different intermediaries have different methods for motivating people, the participation rate in these platforms will vary. Although only one common type of innovation intermediary mechanism is further analyzed, the study embraces various perspectives including managers and participating individuals.

The performed research involved quantitative and qualitative methods that complement one another to throw light on existing theory and previous studies. A combined approach involving point in time quantitative assessments of participation in innovation intermediaries with an in-depth qualitative inquiry can yield a deep and rich understanding of innovation intermediaries in public and private sectors. The overall methodologies are appropriate for these research questions. Nevertheless, some limitations remain despite the fact that this thesis employs a combination of methodologies to ensure the robustness of the results.

It was a challenge to find and construct a case study that is detailed and specific enough to addresses the research questions (Yin, 2003). Cases for innovation intermediaries with different relevant mechanisms are identified for Chapter 3, and a selection is further analyzed in Chapter 4. Quantitative empirical studies are supplemented by qualitative evidence. For Chapter 2, multiple cases in the public sector have been cross-case synthesized. For instance, these studies in Chapter 2 involve not only innovation intermediaries, but also include the city halls with which they collaborate.

Due to the limited time and resources, those cases with different mechanisms which have been exhibited previously will be studied in the future. The obvious drawback of this approach is limited generalizability (Yin, 2003), although numerous findings have been acknowledged in all the organizations and networks observed in this study. Future research could test the current findings and make comparisons with other cases and even use quantitative methodologies.

The framework in Chapter 4 has been developed from the literature and theoretical conceptualizations. The constructs of the theory of planned behavior are used to develop the model for innovation intermediaries. Another model could also have been used, but TPB fits best for answering the research questions.

In terms of implications, the findings presented here are instrumental for organizations, both public and private, and for individuals who must choose an innovation intermediary. The implications provided previously can help organizations identify and handle challenges related to work with innovation intermediaries. They may initially appear not necessarily relevant for each intermediary, since the implications are based on the cases in hand. However, it should be noted that the implications provide in-depth insights for a more detailed understanding of how innovation intermediaries function, their role in the innovation ecosystem, and the changes that need to be made. Governments spend significant amounts of money and effort sustaining regional innovativeness; hence it is important for policymakers to understand the implications of innovation intermediaries. For too long policy makers have neglected to build a framework to manage innovation intermediaries, but with this research the time has come to use intermediaries as an active tool in innovation ecosystems.

This thesis covers a wide range of topics with a variety of methods to target diverse audiences. On the whole, the contributions in this thesis debunk misconceptions regarding innovation intermediaries; while identifying their internal mechanisms, and role in innovation ecosystems. Therefore, the findings in this dissertation have implications for policymakers, innovation intermediaries, and intermediary user companies. With the existing resources and time availability, a number of issues are analyzed in-depth in this thesis and these can be further extended in the future.

5.1.6 Comments for the future

In a more globalised and competitive future, the role of innovation intermediaries is likely to become more important for companies that adapt the open innovation model. The collaborative approach of open innovation requires a new set of capabilities and skills that many organizations do not currently possess. Furthermore, problems related to the transfer of knowledge and co-development escalate with ideas flowing across the firm boundaries. To identify and internalize value from external opportunities, as well as deploying internal discoveries to external markets, companies require an external innovation intermediary (e.g. InnoCentive, Yet2.com) depending on their specific needs (Chesbrough, 2003). Innovation intermediaries can assist these organizations gain access to new ideas and technologies. Intermediaries also enable them to keep pace with evolving markets and changing demands.

Innovation intermediaries facilitate the exchange of innovation by bringing together solution or intellectual property seekers with problem solvers and intellectual property owners (Lichtenthaler & Ernst, 2008; Fredberg et al., 2008). There is currently a great variety of innovation intermediaries, yet some are managed poorly.

As a market, it is very young and dispersed. There are a few established firms such as InnoCentive, NineSigma, and Yet2.com. They do not have a common business model and each offers diverse services such as consultancy. The market is constantly evolving and promises a great future. Even though most innovation intermediaries are mainly concentrated in technology (IP) searching (e.g. Yet2.com), this does not mean that their functions are limited to these areas (Morgan & Crowford, 1996; Bessant & Rush, 1995). The potential use of innovation intermediaries is numerous and can be further expanded in the future. Rather than only providing IP transfer, innovation intermediaries will become more specialized and may eventually provide a platform where issues common to domains and sectors can be discussed. Eventually, there will be an elimination of poorly performing intermediaries and a consolidation in the market. Innovation intermediaries will continue to create radical changes both in public and private sectors.

With the considerable resources that go into establishing and managing innovation/idea challenges, it is natural to ask who ultimately benefits from this approach to innovation.

Clearly, winners of the challenges benefit with monetary rewards, visibility, reputation, and networking.

However, companies mostly benefit from using intermediaries by opening their boundaries and gaining access to external IP in terms of ideas and products, creating possibilities for licensing-out and co-developing, diagnosing cross-industry opportunities, identifying customer needs, evaluating, and filtering external opportunities (Foss & Ishikawa, 2007; Lichtenthaler & Ernst, 2008). This access to various actors, technologies, and information leads to greater productivity for companies and competitive advantages.

In the future, innovation intermediaries are expected to dramatically increase the number of exchanges in the innovation market (Fredberg et al., 2008; Lichtenthaler & Ernst, 2008).

Despite the high potential for innovation, using intermediaries could lead to new management challenges (Sieg et al., 2010). Thus it will create a need for new positions and roles within organizations, such as the community innovation manager of GE (Chesbrough, 2012), who will keep its community alive and engaged. Alternatively, other line managers will have to learn to deal with external innovation communities.

To overcome some of these challenges, new technologies will also support collaborative configurations, enriching mediated actions that facilitate visibility and accountability. These configurations will lead members to participate more while better regulating the platform.

For the implementation of open innovation at regional and national levels, the participation of innovation intermediaries will accelerate as facilitators of innovation systems. The USA and Europe have developed various initiatives for open innovation policies and various open data projects have been established. The tasks and utilization areas of these intermediaries have broadened. Innovation intermediaries in the public sector can help companies transform their new ideas into commercial products and/or services.

It is logical to assume that in the future most governments will adopt open innovation with inside-out and outside-in initiatives following the leading countries. Eventually, innovation intermediaries will play a crucial role in the strategic plan and innovation ecosystem with greater involvement by citizens. This will create transparency and economic benefits for governments.

The use of innovation intermediaries will become more common in public and private sectors and the number of innovation exchanges is expected to significantly increase. Intermediary services will also expand. Meanwhile, future research will explain the growth, and survival of innovation intermediaries and a common framework will be created for measuring their performance. In both sectors, innovation intermediaries will also build large networks and ecosystems to connect businesses, universities, and the public sector for a new economic growth. There will also be clear theoretical guidelines for supporting the management of these intermediaries. ICT can be used to support their services.

In the future there will be a need for new standardization and regulation due to a growing market and the need to protect the rights of online workers. Standardization can be attained through standard documents, procedures, and services. The rights of online members and their work will be protected. The performance of innovation intermediaries will be enhanced with new standards and regulations.

A current major issue is intellectual property (IP), namely, who owns those ideas that are sent? It is one of the major obstacles to implementing open innovation for many organizations. Similarly, another issue is how to assure individuals that their ideas will not be used in other occasions without notice. These obstacles can be solved with new regulations.

It is natural to assume that in the future innovation intermediaries will have a crucial role in the innovation process and will push the boundaries of open innovation. For this reason, various forms of open innovation intermediaries have been presented in this thesis.

5.1.7 Final remarks

This study has analyzed open innovation intermediaries from the perspective of mechanisms, individual motivation, and their role in the public innovation ecosystem. The comprehensive study of online open innovation intermediaries from the perspective of mechanism design explains the underlying functioning of these intermediaries. In addition, in-depth analysis and a comparison of two online open innovation platforms has enabled the identification of the major factors that affect individual participation. Furthermore, the exploration of public open innovation intermediaries and their role with multiple cases expands the existing literature on

open innovation in the public sector. Consequently, this thesis enables the exploration of novel insights and a much richer understanding of the open innovation intermediary phenomenon both in public and private sectors.

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Appendix 1: Chapter 2: The Underlying Mechanisms of Open Innovation Intermediaries

Table 1: List of the intermediaries

Intermediary Name	Establishment Year	Community Size	Logo
Big Idea Group	2000	>13,000 inventors	
Idea Crossing	2004	>6650	
Pharmalicensing	1997	>2100	
Chaordix	2009	-	
Innocentive	2001	>260,000	
IdeaConnection	2007	40,000	
Yet2.com	1999	>130,000	
PRESANS	2010	-	
Hypios	2008	>800,000	
Innoget	2006	Several thousands	
One Billion Minds	2009	Several thousands	
NineSigma	2000	>1,500,000	
RedesignMe	2007	-	
Atizo	2009	11,020	
Innovation Exchange	2008	-	
Ideaken	2009	Several thousands	
Idea Bounty	2008	>25,000	
Brand Tags	2009	-	

Battle of concepts	2007	>6,000	
Brainrack	2009	>1,000	
crowdSPRING	2007	>119,000	
BootB.com	2007	-	
12designer	2009	>13,000	
99designs	2008	>10,000	
Edge Amsterdam	2009	-	
Challenge.gov	2010	>2,200	
eYeka	2006	>217,000	
Ideas Project	2011	-	
Dell IdeaStorm	2007	40,000	
My Startbucks Idea	2008	>30,000	
Brain Reactions	2006	-	
Brainfloor	2008	4,525	
Idea Connection	2007	40,000	
Inpama (Ideawicket)	2010	-	
Top Coder	2000	>415,000	
Spigit	2007	-	
Your Encore	2003	-	
dotOpen	2007	>4,000	
Gen 3 Partners	1999	>8,000	
Hyve	2008	-	

Innovation Framework	2006	-	
Invention Machine	2008	-	
Wilogo	-	>30,000	
Quirky	2009	>236,000	
Ideaken	2009	-	
BeeQuu	2007	>840	
Edison Nation	-	Several thousands	
ideas4all	2008	>28,000	
Cassiber	2007	Several thousands	
Ideas to Go	1979	-	
Openideo	2010	>35,000	

Appendix 2: Chapter 3: Motives for Participation in Online Open Innovation Platforms

Table 1. Scale Items Used

Construct (with reference)	Definition	Item	Wording Nokia	Loadings					
				Model 1. Atizo simple assessed	Model 2. Atizo TPB assessed	Model 3. Nokia simple assessed	Model 4. Nokia TPB assessed	Model 5. Atizo simple real	Model 6. Atizo TPB real
Intrinsic Motives (Amabile, 1994; Berlyne, 1971; Reeve et al., 1986; Kim & Lee,1995; Koys & Decotiis,1991)	The degree to which an individual is motivated to engage in work primarily for its own sake because the work itself is interesting, enjoyable, engaging, or satisfying	IN1	My participation can assist Atizo/Nokia to find solutions for its challenges	0,7851	0,8045	0,6935	0,6843	0,7964	0,8044
		IN2	For me to participate in Atizo challenges /IdeasProject is fun	0,7728	0,7912	0,6264	0,6151	0,7073	0,7911
		IN3	For me to participation in Atizo challenges /IdeasProject is pleasant	0,7584	0,7765	0,8329	0,8537	0,7408	0,7765
		IN4	Participating in Atizo challenges/IdeasProject has been beneficial for my personal development	0,6876	0,6316	0,7728	0,7707	0,638	0,6316
		IN5	I expect that I will enjoy solving problems and generating new ideas in Atizo challenges/ IdeasProject	0,7086	0,7075	0,6653	0,6622	0,7974	0,7075
Extrinsic Motives (Amabile, 1994; Berlyne, 1971; Lepper& Greene, 1978; Gomez-Mejia and Balkin, 1990; Malhotra & Galletta,1999)	The degree to which an individual is motivated to engage in work in response to something apart from the work itself, such as monetary rewards or	EX1	Participating in Atizo challenges/IdeasProject can increase my reputation	0,5113	0,6832	0,755	0,7768	0,5404	0,6832
		EX2	Participating in Atizo challenges/IdeasProject can strength my position and	0,6354	0,6545	0,7644	0,8234	0,5997	0,6545

	recognition or other tangible incentives		visibility						
		EX3	My participation will increase my networking with other members who have common interests	0,5713	0,7163	0,7551	0,7854	0,5475	0,7163
		EX4	I expect to receive some money for my participation in Atizo challenges/IdeasProject	0,581	0,537	0,6181	0,5092	0,5039	0,537
		EX5	I expect to win an award through participating in challenges of Atizo/IdeasProject	0,7281	0,5587	0,7075	0,6207	0,7555	0,5587
		EX6	I expect to receive recognition for my participation in Atizo/ IdeasProject	0,5841	0,6919	0,7491	0,7971	0,5812	0,6919
Attitude (Ajzen & Fishbein, 1980; 1975, 1981; Price & Mueller, 1986; Robinson & Shaver,1973)	The degree of an individual's favourableness of participating in an intermediary	AT1	For me to participation in Atizo/IdeasProject was good	-	0,8928	-	0,8882	-	0,8927
		AT2	For me to participation in Atizo/IdeasProject was beneficial	-	0,5086	-	0,8334	-	0,5088
		AT3	I have a positive attitude towards participating in Atizo/IdeasProject	-	0,813	-	0,7829	-	0,813
Subjective Norm (Ajzen 1991; Mathieson 1991; Taylor &Todd 1995)	The degree to which an individual perceive participating in an open innovation intermediary	SN1	Most people that I know participate in Atizo/IdeasProject	-	0,5773	-	0,7319	-	0,5836
		SN2	Most people value participation in Atizo/IdeasProject as an important issue	-	0,5897	-	0,7184	-	0,5943
		SN3	My colleagues think that I should participate in Atizo/IdeasProject	-	0,6467	-	0,7862	-	0,6416

		SN4	Most people whose opinion I value think that participating in Atizo/IdeasProject is important	-	0,7334	-	0,83	-	0,7277
Perceived Behavioral Control (Ajzen, 1991; 1985)	The degree of an individual's control over his/her participation in an intermediary	PBC1	My organization allows me to participate in Atizo/IdeasProject	-	1	-	1	-	1
Intention (Ajzen & Fishbein, 1980; Lee & Green 1991; Constant et al., 1994; Dennis, 1996; Feldman & March, 1981)	The degree of an individual's willingness to participate in an open innovation intermediaries	IP1	I intend to provide my ideas in Atizo/IdeasProject on a regular basis	-	0,9196	-	0,814	-	0,9241
		IP2	I plan to participate more in Atizo/IdeasProject	-	0,9497	-	0,8824	-	0,9469
		IP3	I intend to participate more in Atizo/IdeasProject	-	0,9368	-	0,8664	-	0,9356
Participation (Subjective)	Assessed participation data based on questions that measure their participation level	PAR1	How often do you participate in Atizo/IdeasProject ?	0,8722	0,8619	0,9155	0,9073	-	-
		PAR2	How often do you check/log in into Atizo/deasProject ?	0,9343	0,9389	0,8875	0,8853	-	-
		PAR3	How often do you come up with a new idea in Atizo/IdeasProject ?	0,9075	0,9111	0,9024	0,911	-	-
Participation (Real)	Real data of ideas, projects, comments, ratings	PAR ideas	Based on the real participation data collected from Atizo log files; number of ideas provided, projects completed, comments given and ratings done	-	-	-	-	0,9137	0,9247
		PAR projects		-	-	-	-	0,8324	0,8076
		PAR comments		-	-	-	-	0,8404	0,8615
		PAR ratings		-	-	-	-	0,8621	0,8572

Table 2. Correlations among the Latent Variables for the Two Simple Models

Atizo Simple Model - Assessed		**Extrinsic**	**Intrinsic**	**Participation**
	Extrinsic	0,5907	0	0
	Intrinsic	0,3246	0,7434	0
	Participation	0,4781	0,5538	0,9049
Atizo Simple Model - Real		**Extrinsic**	**Intrinsic**	**Participation**
	Extrinsic	0,5796	0	0
	Intrinsic	0,3372	0,7383	0
	Participation	0,4248	0,2414	0,8627
Nokia Simple Model - Assessed		**Extrinsic**	**Intrinsic**	**Participation**
	Extrinsic	0,7266	0	0
	Intrinsic	0,669	0,722	0
	Participation	0,4378	0,5256	0,9018

*All correlations are significant at $p = 0.05$.

**The figures in the shaded diagonal row are the square roots of the average variance extracted.

Table 3. Correlations among the Latent Variables for the two TPB Models

		Attitude	Extrinsic	Intention to Participate	Intrinsic	PB Control	Participation	Subjective Norm
Atizo TPB Model – Assessed	**Attitude**	0,7564						
	Extrinsic	0,4248	0,6081					
	Intention to Participate	0,5036	0,4221	0,9354				
	Intrinsic	0,8097	0,3708	0,4887	0,745			
	PB Control	0,0851	0,3108	0,1349	0,1806	1		
	Participation	0,5132	0,4165	0,5203	0,5412	0,2179	0,9045	
	Subjective Norm	0,0758	0,3234	0,2738	0,2087	0,4582	0,1048	0,6387
		Attitude	**Extrinsic**	**Intention to Participate**	**Intrinsic**	**PB Control**	**Participation**	**Subjective Norm**
Atizo TPB Model – Real	**Attitude**	0,7564						
	Extrinsic	0,4248	0,6081					
	Intention to Participate	0,5025	0,4241	0,9355				
	Intrinsic	0,8097	0,3708	0,4869	0,745			
	PB Control	0,3729	0,1041	0,1757	0,3579	1		
	Participation	0,2246	0,336	0,2502	0,2202	-0,0832	0,8637	
	Subjective Norm	0,0759	0,3235	0,274	0,2081	-0,0017	-0,0115	0,6392
		Attitude	**Extrinsic**	**Intention to Participate**	**Intrinsic**	**PB Control**	**Participation**	**Subjective Norm**
Nokia TPB Model - Assessed	**Attitude**	0,8359						
	Extrinsic	0,6525	0,7278					
	Intention to Participate	0,7269	0,7141	0,8547				
	Intrinsic	0,7826	0,6854	0,7123	0,7222			
	PB Control	0,1359	0,3003	0,1259	0,1594	1		
	Participation	0,4573	0,4238	0,4643	0,523	0,0728	0,9012	
	Subjective Norm	0,5396	0,6296	0,5831	0,532	0,2464	0,3606	0,7679

* All correlations are significant at $p = 0.05$.

**The figures in the shaded diagonal row are the square roots of the average variance extracted.

Table 4. Scale Reliability Comparison for Simple Models (Measurement Model Assessment)

		Intrinsic	Extrinsic	Participation
Atizo Simple Model-assessed	**AVE**	0,5527	0,349	0,819
	Composite Reliability	0,8604	0,7594	0,9314
	Cronbachs Alpha	0,7978	0,65	0,8895
	Mean	0,4457	0,3448	-
	Standard Deviation	0,0449	0,068	-
Atizo Simple Model-real	**AVE**	0,5452	0,336	0,7443
	Composite Reliability	0,8562	0,7468	0,9208
	Cronbachs Alpha	0,7978	0,65	0,8856
	Mean	0,116	0,3932	-
	Standard Deviation	0,0536	0,0502	-
Nokia Simple Model-assessed	**AVE**	0,5214	0,528	0,8134
	Composite Reliability	0,8434	0,8698	0,929
	Cronbachs Alpha	0,7671	0,8201	0,8854
	Mean	0,4264	0,1632	-
	Standard Deviation	0,0821	0,0782	-

Table 5. Scale Reliability Comparison for TPB Models (Measurement Model Assessment)

		Intrinsi	Extrinsi	Attitud	Subjectiv	PB Contr	Intention t Participate	Participatic
Atizo TPB Model-assessed	AVE	0,5551	0,3699	0,5722	0,4093	1	0,8751	0,8182
	Composite Reliability	0,8609	0,7588	0,7926	0,733	1	0,9546	0,931
	Cronbachs Alpha	0,7978	0,65	0,6088	0,618	1	0,9288	0,8895
	Mean	0,7554	0,1482	0,4821	0,2487	0,15	0,4991	
	Standard Deviation	0,0325	0,046	0,0536	0,0583	0,0727	0,072	
Atizo TPB Model- real	AVE	0,5551	0,3699	0,5722	0,4087	1	0,8753	0,7461
	Composite Reliability	0,8609	0,7588	0,7926	0,7329	1	0,9547	0,9214
	Cronbachs Alpha	0,7978	0,65	0,6088	0,618	1	0,9288	0,8856
	Mean	0,7547	0,1494	0,4799	0,2503	-0,1398	0,2755	
	Standard Deviation	0,034	0,0489	0,0518	0,0571	0,072	0,0635	
Nokia TPB Model-assessed	AVE	0,5216	0,5297	0,6988	0,5897	1	0,7306	0,8123
	Composite Reliability	0,8432	0,8683	0,8741	0,8514	1	0,8904	0,9285
	Cronbachs Alpha	0,7671	0,8201	0,7828	0,767	1	0,8148	0,8854
	Mean	0,63	0,2244	0,5785	0,274	0,0153	0,4671	
	Standard Deviation	0,056	0,0631	0,053	0,0575	0,0593	0,0506	

Table 6. Summary of Simple Models

		Intrinsic	Extrinsic	Participation
Atizo Simple Model-assessed	**R Square**			0,4062
	T Statistics	9,9216	4,9033	
	Standard Error	0,0449	0,068	
	Path Coeffients	0,4456	0,3335	
Atizo Simple Model-Real	**R Square**			0,1913
	T Statistics	2,0673	7,7218	
	Standard Error	0,0536	0,0502	
	Path Coeffients	0,1108	0,3874	
Nokia Simple Model-assessed	**R Square**			0,2897
	T Statistics	5,1282	1,9945	
	Standard Error	0,0821	0,0782	
	Path Coeffients	0,4212	0,156	

(*** significant at 0.001; **significant at 0.05; *significant at 0.01)

Table 7. Summary of TPB Models

		Intrinsic	Extrinsic	Attitude	Subjective Norm	PB Control	Intention to Participate	Participation
Atizo TPB Model-assessed	R Square			0,6736			0,3094	0,2929
	T Statistics	23,2939	3,1422	9,0579	4,0649	2,0694	6,9465	
	Standard Error	0,0325	0,046	0,0536	0,0583	0,0727	0,072	
	Path Coeffients	0,7561	0,1444	0,4856	0,237	0,1505		0,5
Atizo TPB Model-Real	R Square			0,6735			0,3085	0,0793
	T Statistics	22,2546	2,953	9,3592	4,1538	1,8213	4,3054	
	Standard Error	0,034	0,0489	0,0518	0,0571	0,072	0,0635	
	Path Coeffients	0,7561	0,1445	0,4845	0,2373	-0,1312	0,2732	
Nokia TPB Model-assessed	R Square			0,6379			0,5799	0,2158
	T Statistics	11,3006	3,4722	7,4406	4,6856	0,2452	9,1465	
	Standard Error	0,056	0,0631	0,0361	0,0575	0,0593	0,0506	
	Path Coeffients	0,6326	0,2189	0,5816	0,2693	0,0145		0,4624

(*** significant at 0.001; **significant at 0.05; *significant at 0.01)

Appendix 3: Chapter 4: The Role of Public Open Innovation Intermediaries in Local Government and the Public Sector

Semi-Structured interview guide for public agencies (intermediaries):

- How are you founded? Where is your funding come?
- How do you work/ function as an agency for the city hall?
- What are the main motivations for you to collaborate with city halls?
- What kind of projects do you work on?
- How do you decide to work on which project? What are your criteria & objectives? Who decide on this?
- What are the conditions that you need from city hall? What are the requirements that you need from other organizations to participate in projects?
- What is the role of city halls during the projects? At what level do you collaborate & interaction? Could you provide examples and cases to support this interaction?
- What are the main obstacles that you face with during this collaboration process?
- What are the future strategies for your collaboration with the city hall? How should it be in the future? How the city governance should change in order to facilitate the collaboration?

Semi-Structured interview guide for City halls:

- Why do you need to collaborate with public agencies (e.g. 22@barcelona)? What are the main motivations? How do these agencies facilitate the interactions with communities and other organizations? What are their main benefits for city hall?
- How do you decide which public agency to support and collaborate with? Is there any link with region or origin of the agency? What are the main criteria? How do you evaluate them?
- How do you interact with these agencies? How do you govern them? How do you manage the information flow?
- What are the main objectives and criteria in the selection process of projects?
- What kind of roles does city hall give to these agencies?
- How often do you collaborate with them? How is your relation with these agencies, long term, or project based?
- How does this interaction foster innovation?
- What kind of resources do you devote in for collaboration?
- What are the focal challenges that you face during the collaboration?
- What are the future strategies for this interaction with these agencies? How will this interaction change in the near future? How should it be in the future?

Appendix 4: Related Work

A research report commissioned by ESADE Business School & Science I Business

In collaboration with: Prof. Dr. Henry CHESBROUGH, Prof. Dr. Wim VANHAVERBEKE and Henry LOPEZ-VEGA

Executive summary – open innovation and public policy

Industrial innovation processes are becoming more open. The large, vertically integrated R&D laboratory systems of the 20th century are giving way to more vertically disintegrated networks of innovation that connect numerous companies into ecosystems. Since innovation policy ultimately rests on the activities and initiatives of the private sector, it is vital that policy follows this evolution to enable a more open innovation environment.

Previous innovation policies relied on large companies to act as the engines of innovation in the EU. While large companies remain quite relevant to innovation within the EU, they themselves report that their processes involve many more SMEs and other contributors outside their own walls. Therefore, innovation policy must also move outside the walls of

these large companies and consider the roles of human capital, competition policy, financing, intellectual property, and public data in promoting an environment of open innovation.

In this report, we combine new research and analysis on open innovation with focused interviews of major participants in the European innovation system. While our respondents did not agree on every topic, there was a strong consensus that there were important opportunities for innovation policy to improve the innovation climate within Europe. The respondents also tested our assumptions about open innovation, and helped us focus on its most pressing aspects to guide our recommendations for policy. We wish to thank them for their generous time and contributions. We also welcome comments from readers. Email us at openinnovation@sciencebusiness.net.

Summary recommendations

1. Education and human capital development

Increase meritocracy in research funding within the EU.

Support enhanced mobility during graduate training.

2. Financing open innovation: the funding chain

Increase the pool of funds available for VC investment.

Support the formation of university spin-offs to commercialize research discoveries.

3. Adopt a balanced approach to intellectual property

Reduce transaction costs for intellectual property.

Foster the growth of IP intermediaries.

Rebalance EU policy towards universities with publicly funded research.

4. Promote cooperation and competition

Abandon policies to support national champions, and shift support to SMEs and start-up companies.

Promote spin-offs from large companies and universities.

Focus on innovation networks.

5. Expand open government

Accelerate the publication of government data.

Use open innovation processes in government procurement.

Support private commercialisation of government funded technology.

1. Introduction: open innovation & public policy

Open innovation relies heavily upon the availability of external knowledge that companies assimilate and integrate into their businesses. Yet, the stock of available knowledge and its availability to firms cannot be taken for granted. This knowledge is the result of numerous, and often unconnected, public policies regarding science, technology, intellectual property (IP), and education within society. In this report, we will bring these background elements to the fore, and ask how governments can craft policies that support innovation in a world of widely dispersed knowledge, mobile workers, and abundant venture capital (VC).

Many current public policy measures have their roots in the closed innovation era. As we will argue, this approach is increasingly outdated and even harmful in a world of open innovation.

1.1 Public policies inspired by closed innovation thinking

Many past and present innovation policies stem from a logic that is reminiscent of a closed innovation mindset:

- Focus on developing a large national or European market
- Protect European companies from foreign innovators
- Limit the number of foreign workers and students in Europe
- Give subsidies and credits to the largest firms to keep them innovating nationally or regionally
- Make sure that government funds go to national and European firms, and avoid giving assistance to foreign companies

These are the prescriptions that stem from an assumption of economic autarky, where national economies operate largely independently of one another. These recommendations come from so-called economic nationalists, mercantilists, and others who oppose free trade, and promote the national government as the logical and necessary champion of domestic interests against foreign intrusions. In some European countries, this attitude continues in automobiles, banking, and agriculture. Similarly, until recently some European countries treated large companies in particular industries as 'national champions' and channeled subsidies towards them while restricting competition with these champions.

Science and technology are nowadays widely diffused across the world. Some authors even claim that companies only can introduce leading edge products if they source the required technologies globally (Doz et al. 2001). This indicates that economies are shifting towards an era of open innovation and it is time to replace closed innovation policies with policy initiatives that are in line with the imperatives of open innovation (see textbox). Most technologies are, nowadays, developed through a global network of technology partners. The number of technologies (even those that are thought to be crucial for national security) that can be developed and exploited within national borders is decreasing rapidly. Currently, no

national or European government can reasonably hope to exclude a hostile government or interest group from having access to these technologies.

Open innovation in the pharmaceutical sector

The pharmaceutical industry has always collaborated with external partners. Collaborations with universities and academics are a routine part of our early research. Collaborations with clinicians and hospitals are the only way that we conduct clinical trials for the development stages of R&D.

The pharmaceutical industry has routinely licensed in medicines from other companies and biotech companies. Often, medicines developed by SMEs stand the best chance of reaching the market through licensing deals or acquisition since the costs and risks of late stage development require the kinds of financial resources and expertise available to large companies.

More and more stages of the R&D process are being undertaken through collaboration or out-sourcing. There are many different models for creating effective collaborations from bi-lateral contracts to large collaborative consortium approaches. Pfizer also has a venture fund and a variety of external research experts dedicated to finding partners and generating new deals and collaborations.

Much more information about every aspect of medicines research is now publicly available. Maximizing the value of the information relies in part on information management infrastructure that allows flexible access to data. There are challenges in identifying common terminology and quality assurance frameworks to make the information broadly useful. There are some important examples in Europe where these issues are being addressed (Pistoia Alliance, IMI Knowledge Management programs).

The trend is certainly toward increased knowledge sharing to accelerate innovation, but competition is also an important driver of quality and speed in developing novel medicines. The right balance between sharing information and creating competition will vary along the R&D path.

Adam Heathfield, Science Policy Director at Pfizer

A similar reasoning applies to national procurement regulations in European member states for military and other technologies. Most national procurement regulations – especially those with military or national security applications – were born in a mindset of closed innovation; and do not fit in an open innovation world. The increasing globalization and rapid proliferation of open innovation implies that governmental agencies cannot effectively exclude others from accessing widely available technologies. The same erosion factors that have caused private firms to move away from the closed innovation mindset are also forcing innovation policies to move away from this approach. In the United States, for instance, experiments along these

lines came from the CIA when it contributed financial capital to start a venture firm, InQTel. This VC firm is chartered with finding innovative start-ups to commercialize important software and communication technologies. Importantly, InQTel does not need to follow any federal procurement regulation guidelines, and provides the CIA access to technologies that were previously difficult to access. In the UK, Qinetiq represented during its first years a similar initiative to set up commercial applications for military technologies. These initiatives make far better use of today's knowledge environment than policies based on a closed innovation logic.

1.2 The new division of innovation labor

Chesbrough's seminal book on open innovation (2003) examined several erosion factors that led to the decline of closed innovation. They included:

- increasing mobility of trained engineers and scientists
- increasing importance of venture capital
- greater dissemination of knowledge throughout the world
- increased quality of university research
- increased rivalry between companies in their product markets.

These factors help to enable a new division of labor in the funding, conduct, and focus of research and development (R&D) in innovation systems. This new division has caused businesses to shift the focus of their internal efforts from more basic research discoveries towards more external sources of knowledge, and has caused businesses to seek new business uses for their knowledge more aggressively than in the recent past.

However, one important difference between the perspective of a firm and the perspective of a society is that a firm benefits from a single clear and coherent business model; while knowledge-intensive societies benefit from a multiplicity of business models competing to create value out of ideas. Venture capital has become an integral part of the innovation system in leading OECD countries, and combined with increased labor mobility, the result has been a larger role for small and medium sized businesses (SMEs) in the industrial innovation systems of these countries. These SMEs offer society a variety of possible business models vying to create value out of knowledge.

Starting up new companies and growing them into global businesses is crucial for the economic growth of an economy. Although it is beyond the scope of this report it would be interesting to analyze the age of European companies in the worldwide top 1000 list, and compare the average age and sales growth over the last decade with their peers in the US, Japan, Korea, and China. European companies in the top 1000 are undoubtedly much older on average and their average annual growth is lower than their American counterparts. The US economy has spawned new global players in industries that were embryonic or non-existent 20 or 30 years ago; examples include Microsoft, Dell Computer, Cisco Systems, America Online, Genentech, Amgen, Millennium, eBay, Google, and Facebook. These firms are the tip of an iceberg and there is a much larger and continuous stream of new ventures that have been established during the last three decades.

Both the American and European economies have lost market share in manufacturing industry to the more efficient and responsive manufacturing systems of Japan and some other emerging Asian economies. The difference is that the European innovation system has been unable to copy the dynamism of the American innovation system over the last 20 years. In fact, both Europe and the US have lost ground in most industries. Much of the American increase in productivity was the result of new high-tech industries, such as personal computers, mobile technologies, networking, biotechnology, and nanotech. Europe had its own growth companies in these industries but their economic boost was not comparable with the US. Much of the American resurgence came from the ability of new firms to discover new industries, and of society's ability to redirect human, financial, and technological resources to these new firms and away from the distressed industries. Moreover, this change went hand in hand with a more fundamental change in how innovation systems functioned. Internal R&D within large businesses became less important and gave way to external sourcing of technology as SMEs and universities became strong technology players.

If Europe wants to keep or improve its competitive position in the globalizing knowledge economy in the next decade, then public policy has to develop some basic guidelines that are in line with the imperative of open innovation. We will develop some suggestions for these policy guidelines in the following sections. Firstly, we focus on education and human capital development and diffusion. We then analyze how the transition from closed to open innovation requires new funding systems. Thirdly, we tackle policy issues related to

intellectual property. Fourthly, we look at how open innovation encourages policy makers to look at networks rather than individual firms – and to promote competition and rivalry in product markets. Finally, we look at some topics related to open government. We finalize this report by drawing some conclusions that can be considered a charter for open innovation policies in Europe.

2. Education and development & the diffusion of human capital

Open innovation can only thrive in a society when two key conditions are fulfilled: the educational system must systematically create highly qualified labor; and knowledge workers must be highly mobile. There is a general consensus (in Europe) that the government has to foster the creation and diffusion of high quality knowledge within society. To realize this objective a society's educational system has to take a central role in innovation policymaking. Related to issues of creating a skilled workforce, are policies that facilitate the mobility of that workforce. Pensions, social security, healthcare, and other aspects of compensation are typically tied to employment, and this effectively constrains mobility. Making these benefits portable, or severing their tie to a specific employer, would enable workers to seek the best opportunities to use their skills.

2.1 Human capital creation

Fostering the creation of high quality knowledge in a society puts the educational system at the centre of innovation policymaking. Developing and maintaining a skilled labor force requires governments to deliver high quality education at the primary, secondary, and university levels. Education is the focal approach for governments to foster the development of labor skills and talents. In general, schools at primary and secondary levels in most West European countries are evaluated as the best worldwide.

2.1.1. Developing new generations of students more effectively

Top level research and technology development hinges on the availability of excellent scientists and researchers. Universities play a key role in educating new generations of

researchers and scientists. The faculty and graduate students within universities are a vital human capital resource in generating knowledge. Europe faces some serious problems in the production of excellent faculty and researchers. A quick look at the worldwide ranking of EU universities compared to American universities in terms of publications and citation indices, Nobel prizes, valuable patents, and university spin-offs shows that the Americans do better in academic research. The relative position of Europe is also worsening as several non-western countries are rapidly upgrading their educational and knowledge infrastructures and quickly climbing in the international rankings.

Firstly, there is no transparency in the European educational system. As there are no general rankings it is not easy to compare universities in the same country, and international comparisons within Europe are much harder. It is crucial that European policy makers set up a ranking system for universities in Europe. We should measure and evaluate universities comparatively, have access to league tables, rankings, etc. Those rankings are crude and any metric is simplistic. However, rankings offer at least some transparency regarding the quality of universities and other educational institutions. MBA-school general rankings would offer students valuable information about how much value they can expect for their money. As a result, good students would look for good universities, and so offer Europe much better generations of researchers. But rankings have other advantages too. When rankings were introduced in the UK, university managements began to think about the strengths and weaknesses of each university. As a result, they either addressed their weaknesses or started differentiating their offerings from other universities by building on their strengths. It can be concluded that these assessments and ranking systems are valuable. However, policy makers should be careful about how these metrics are used to control funding.

2.1.2. The growing role of universities in advancing basic research

As well as educating new students and researchers as a key resource, universities and related research institutes also play an important role in advancing basic research. Only two decades ago, large industrial companies had enormous corporate R&D centers where research was oriented towards the mission of the company and each centre had greater scientific and technological capabilities than most universities. The majority of these central labs were

dismantled – especially during 1990s – because large companies were forced by shareholders to focus on short-term profits. Long-term research by central research labs was increasingly seen as expensive and of dubious value. At the same time, the governments (especially in the US) were investing in research systems, national labs, and major universities. In this way, the incentives for large companies to tackle (basic) research themselves, rather than working with major universities and, more generally, the innovation ecosystem existing in different countries, became weaker and weaker. In consequence, as companies focused increasingly on applied sciences and the development and commercialization of technologies, universities became the major (and maybe only) institutions driving basic science research. Since companies are gradually withdrawing from basic research, governments have to make investments in fundamental science – which, if managed appropriately, is a major source of new technological developments. The success of the Defense Advanced Research Projects Agency (DARPA) in funding basic research in the US in information technologies is a demonstration of how government funding, directed to decentralized research institutions, can yield cumulatively important research outcomes.

> "In the 20th century big companies had massive internal R&D centers with more ability, more capability than many universities, and oriented towards the mission of the company. These were largely dismantled, towards the turn of the century, because they were increasingly perceived as high cost for which people could not identify corresponding benefits. And of course at the same time governments have been investing, especially in America I would say, in their research system, for example national labs and major universities. Hence the business case for doing it yourself, rather than working especially with universities but more generally the wider innovation ecosystems in different countries, became weaker and weaker." *David Eyton, Head of Research and Technology at BP*

During our interviews with leading R&D managers in major industrial companies in Western Europe, there was a surprising unanimity that top research in Europe is not 'in good shape' because of institutional inhibitors. Top research hinges on top researchers working in top institutes. Large manufacturing companies are interested in accessing the fundamental research capabilities of top-performing universities and research labs, but not second-tier universities. Hence, what counts is the presence of world leading research labs such as

Lawrence Berkeley National Lab, CERN, Cambridge Research Lab, Scipps Research Institute, SRI International, etc. and companies are willing to invest in these institutes (as witnessed by the many collaborative institutes set up by Microsoft or pharmaceutical companies). Top researchers will work in universities and research institutes that can offer leading edge knowledge infrastructures, interesting connections or collaboration opportunities with other top researchers, and large, long-term projects (5-10 years depending on the technological field). The latter is necessary as it enables researchers to build a faculty that is large enough to cope with important scientific problems and there is enough time to move the scientific frontier through scientific publications, etc.

Europe faces problems in generating sufficient top-level research that can compete with universities and research institutes on a global scale. One of the problems is that unlike agricultural budgets, R&D budgets are still in national budgets. Of course, Europe has launched a number of initiatives such as the European Research Council (ERC) but the budgets are limited in comparison with the budgets of the National Science Foundation (NSF), the National Institute of Health (NIH), and a number of private American foundations. As a result, there is no pan-European competition between universities as in the US. What provides the drive at American universities to have the best researchers and labs? Every lab must be funded every 4-5 years through national competition. If a research team has the best proposal, it receives grants and can expand. If not, the team will lose its best scientists. It is very dangerous to decide in advance which is the best research lab and there is a tendency in nations such as France for the state to decide who receives funding. Permanent competition is the best way to match budgets to the best technology. To this end, the European Commission should convince member state to transfer part of their R&D budgets to the ERC in order to increase pan-European competition between universities.

The current system used in the Seventh Framework Programme (FP-7) projects, or other European grants, is not really a contribution to pan-European competition between universities/research labs. The requirement that research partners collaborate with many different universities and many different companies in an FP-7 program means added costs and also slows the pace of the program. In many cases, this means that European projects cannot be delivered on time and so participants lose their competitive edge. Therefore, top researchers with a great technology that they want to scale or develop are likely to find

funding in the US or elsewhere where administrative procedures are quicker and grants are usually larger. Teaming up with different organizations and people in different countries is very hard work. In many cases, researchers actually need to team up with just a few people in order to get things done. Therefore, collaboration should be solely determined by whether or not the researchers feel that collaboration would improve the quality of the proposition. The most recent research programs of the ERC go in this direction: the selection is truly competitive and researchers determine themselves the level of collaboration necessary to make a project successful. Research programs should be made competitive on a pan-European scale and universities should collaborate only if it actually improves the proposition.

2.2. Knowledge diffusion

While a strong educational system is vital to knowledge, diffusion of that knowledge is as crucial as creation to spur innovation within society. There is a great deal of value to be realized from unshackling these valuable knowledge resources at universities. Yet many European countries have long-standing policies that constrain the diffusion of knowledge from universities to industry. For example, university lecturers in many European countries are civil servants, and subject to strict prohibitions on working with and for private companies as long as they draw a public salary. Consequently, universities cannot learn from management practices in industry. Graduate students in many of these same countries are effectively indentured servants of the lecturers they work for, and such students lack the ability to seek out the best places to apply the cutting edge knowledge that they are learning.

Regulations that impede the mobility of knowledge workers have unintended side effects. They deprive universities of the knowledge that comes from working closely with industry, and from acquiring a profound understanding of industrial problems. When faculties select their next research initiative, they do so in ignorance of the burning issues that need to be addressed in many areas. This ignorance multiplies when university staff review the research proposals of their peers to allocate funding resources, or oversee the training of their 'indentured' servant students. Research by Van Looy et al. (2004) demonstrates that researchers who work closely with companies doing applied research achieve higher quality rankings for their fundamental research than peers who do not collaborate with industry.

Therefore, contrary to the traditional thinking, academics do not face a trade-off between collaborating with industry and doing fundamental research. Both activities are highly complementary.

Diffusion of knowledge between universities and the business community would be dramatically improved if academia could temporarily be employed in private companies and vice versa. However, there are serious barriers to the mobility between the business community and the academic world. This mobility is difficult to achieve because if a researcher leaves one career ladder for another, the clock stops on the ladder he left. So, if an academic researcher leaves to work in a company and later returns, he or she cannot be promoted because they will not have published any papers during their absence from the university. A similar pattern emerges when managers take an academic post for several years. However, there is some flexibility in this area. Some companies are sending managers to academia as part of their career development and this can work very well. This requires that the courses be adapted for the transition and that industry has a model of career development that purposively advances the capabilities of managers.

> "So partnering with academics has been very important for us... it helps us in recruiting and also encouraging these academics to use our software in their research." *Dr Andrew J. Herbert, Chairman at Microsoft Research EMEA*

Labor mobility eases the tacit knowledge flow between organizations. Mobility also induces networking between organizations and knowledge spillovers (Cohen and Fields 2000). Therefore, the productivity of a skilled workforce is determined by the quality of the skills as well as the mobility of the workforce. A fast flow of ideas generates more value than ideas that are locked into the boundaries of a single company. There are however, many regulatory barriers impeding the mobility of knowledge workers. Firstly, pensions, social security, healthcare, and other aspects of compensation are typically tied to employment, and this constrains the mobility of any worker. Making these benefits portable, or severing their tie to a specific employer, would enable workers to seek out the best opportunities to use their skills. There is an urgent need in the EU to change this situation. Moreover, social legislation is largely determined by national authorities, which implies that labor movement between member states involves plenty of complicated paperwork.

> "I think mobility is fundamentally a very good thing in the world of ideas and innovation. So it is healthy if the research community in Europe can move around."
> *David Eyton, Head of Research and Technology at BP*

Policy makers should also reconsider immigration policy in the European Union. Simplified immigration procedures, and more encouraging immigration regimes that prioritize highly educated immigrants will increase the quality of research. International labor mobility matters with an aging active population in Europe. There is an urgent need to develop a European economic immigration policy that lowers immigration barriers for a highly qualified labor force. This has proven to be a useful strategy for the US, where a continuous inflow of highly qualified labor has supported American scientific, technological, and economic strength for decades. This also implies that European policy makers should abandon the policy of limiting job positions to Europeans.

The EU could also learn from mobility policy in China, which has adopted a number of initiatives to encourage Chinese citizens who were working abroad to return to China later in their careers. These so-called 'returning sea turtles' bring a wealth of international business and scientific expertise with them, and help to rejuvenate the culture of the organizations in China that they join upon their return. However, this policy can only work when the research conditions in Europe are similar (or better) than those abroad. Top researchers will not return to their home country when the conditions for research are worse than those abroad.

Yet another area for EU reform is policy toward retirees. Current labor policy effectively shunts retirees out of the innovation process. Yet with the continued progress in healthcare, longer life expectancies, and an aging population in most EU countries, there is too much valuable knowledge residing in the minds of retirees to be neglected. The time has come to tap into this source of 'seasoned' knowledge – whether it is through coaching, mentoring, teaching, project work, or other less-than-full-time employment.

3. Financing open innovation: the funding chain

The European Commission must consider new ways to channel financial resources to promising new ideas and business models. While education produces knowledge, it requires financial capital to take those ideas to market. Many traditional innovation policies erroneously provide direct incentives to companies (usually large companies) to undertake

R&D. Such incentives take no account of the erosion factors confronting the recipients of these incentives, and under-serve small and medium sized enterprises (see Chesbrough 2003, 2006). While companies will surely pocket incentives for research, their willingness to undertake additional research internally is offset by the problems of diffusion, of being able to profit from the technology they develop. As the problems of diffusion and abundance of knowledge grow, increasingly more incentives will be required to stimulate the same level of R&D within firms.

Approaches focusing on direct incentives to conduct R&D will increasingly be ill-advised, because this approach requires public managers to make judgments about the prospects and merits of innovation activities by specific companies. These judgments are inherently subjective, and are best left to private equity suppliers, who compete to supply capital to promising opportunities. Competition enables a diversity of innovation approaches to be funded, and elicits greater investment in governance by the suppliers of this capital. These owners will also be able to adapt much more readily to new information than public servants. If open innovation is about playing poker, and discovering viable business models, then capital markets must be open as well, so that multiple experiments are funded, and markets can choose the winner.

The European Commission should focus on the most important (three or four major) reforms in Europe instead of working on 30 small proposals. If highly innovative companies drive economic growth, then focus should be on the economic world and the funding chain. The funding chain conceptualizes the need to have appropriate types of funding for all stages – from research to the establishment and growth of a new venture. In each stage, the type of funding has to change and different funding partners will be involved. Compared to the traditional innovation policy guidelines in Europe, more attention should be paid to the appropriate funding of the commercialization of new ideas into real business opportunities. A smoothly working VC market is a crucial element in the funding chain.

The size of the venture capital market in Europe is about one quarter of the US venture capital market. Therefore, the size of the venture capital market must be increased. Moreover, there is the problem of the current weakness of the stock market. The role of VCFs is to finance ventures for a number of years. These ventures then need to grow and become competitive.

Accordingly, in areas where technology cycles are long (especially in biotech, medical devices, and aerospace industries) a venture cannot grow into a large company in just 5 years – and between 10 and 20 years are needed. If there the stock market, then VCs often have to sell the company prematurely to large acquiring companies. Acquisition by large companies is fine if economic reasons (such as complementary assets and global reach) drive the acquisition. But acquisitions that occur because VCs have run out of money clearly lead to suboptimal solutions from a welfare point of view. Moreover, when the main acquirers are American companies in biotech for instance, the result limits economic growth in Europe. It is thus a matter of encouraging more investments into these start-up firms.

Unfortunately, new regulations for banks and insurance companies are having the effect of reducing their investments in the stock market and this is damaging for start-up ventures. Europe should have a proactive reform. Financial savings could, for instance, be channeled for 5-7% into rapidly growing and innovative companies. Europe has the highest saving rates in the world, but they are invested in low risk and poorly productive investments. Much is invested in corporate and government bonds, but very little in growing companies. The European Commission could launch the following measures:

1. Clearly define the target companies (make sure the rule cannot used for other purposes). These companies should be independent (not subsidiaries of larger companies). They should have an R&D rate of > 15-20 % of their overall expenditure and they should not be more than be 10 years old. We have to define these target firms very well because all too often legal vehicles are created to capture European investments.
2. Though tax or other incentives, a small percentage of financial savings should be invested in this type of company.

These measures could help stop too many ventures being acquired too early by larger companies because the VC financing falls short. With the right investments, European high-tech ventures could in this way create more economic growth in Europe.

4. Adopt a balanced approach to intellectual property

A government that wants to promote open innovation practices should provide private firms with enough protection to induce them to invest in creating new IP. At the same time, a

government has an over-riding interest to ensure that the technology is commercialized in as many applications as possible and disseminated widely throughout society. Policy makers should remain concerned with this apparent trade-off between incentives to innovate and those that promote diffusion. But recent shifts in the R&D strategies of private firms may suggest that markets for technology can play a more important role in promoting diffusion than in the past (Arora and Gambardella, 2010). As companies look to make greater use of their IP outside of their own businesses, the supply of knowledge available in the market should increase. Thus, governments should clarify the ownership of IP, and provide the institutional and legal support for its purchase and exchange.

However, this clarification of IP ownership should also be limited in the scope of its coverage. In open innovation, firms invest in R&D to extend their current business models, and occasionally, to search for other business models. These firms, though, cannot and do not make every conceivable use of their ideas within their own walls. Innovation policies for the protection of ideas must accept the limits of what any single firm can do with its ideas and technologies, and promote the recombination and reuse of the available knowledge in other companies. Companies and individuals will continue to generate new knowledge, and some portion of this new discovery will prove to be of enormous value. Direct expropriation of such ideas without compensation would be a terrible policy. But granting wide-ranging ownership rights to ideas that are not strictly controlled in their novelty, usefulness, and non-trivial nature is equally problematic. The first instantiation of an idea is often incomplete. Granting broad ownership rights could strangle the follow-on innovative work that enhances the value of that idea. For similar reasons, granting ownership rights to ideas for very long periods of time can be problematic. A balance must be struck, such that there are adequate incentives to undertake research, and there are also incentives to diffuse these discoveries widely in a variety of applications throughout society.

The innovation system in Europe plays a crucial factor in determining how well inventors/innovators are legally protected and how many incentives they have to share different types of IP with other organizations.

4.1 Open innovation fostered by high quality patents

An intellectual property system works properly under two conditions. Firstly, the patent office must guarantee a sufficient level of quality in the screening of applications. Secondly, the system should be cost effective and affordable for SMEs or start-up companies. We analyze these two conditions respectively in this and the following section.

The European Patent Office (EPO) has the reputation of granting only high quality patents: European patents are very robust and this is a great strength of the system that needs to be acknowledged and maintained. When the EPO grants a patent to an inventor or innovating firm, it already signals some embedded value when the inventor wants to license the technology, or when the start-up receiving the patent seeks external financing. The EPO approach also prevents companies becoming easily blocked (in developing or producing new products) by poor quality patent families owned by other companies or patent trolls as is/was the case in the USA (the strategy of the USPTO has changed in the last few years in this regard).

Clear legal protection of high quality patents is not in contradiction with an open innovation policy that strives to provide adequate incentives to undertake research and diffuse these discoveries widely. In fact, open innovation would literally be impossible without IP protection and rights, which provides the legal infrastructure upon which firms can share their most innovative research and work together to create new products and services. Without strong and clear IP rights, firms would naturally resist sharing their ideas in markets for ideas and technologies for fear that competitors would steal their discoveries. It is through the assured protection of such rights that firms are able to share their innovations with each other – secure in the knowledge that each is fully protected in deploying them to mutual advantage.

Shifting from an in-house model of R&D to a more open and distributed model increases rather than reduces the need for robust IP protection. In fact, IP can be a strong framework within which innovation is organized and managed. In cases where the separate tasks of developing a new medicine, for instance, are conducted by different companies or groups, the overall financial return from commercial sales still needs to cover the costs of each step plus produce profit margins for each participant. So, there is a need to generate the same or greater returns in order to sustain all the parts of the R&D ecosystem. The clean hand-over between different agents in the R&D process also relies on robust IP. Within an open

innovation framework, IP is not a fence preventing others from making use of a protected technology; but rather a bridge to collaboration with other firms and organizations. However, inter-firm collaboration and technology transfer does not emerge automatically. Good IP protection is a necessary condition for open innovation but not yet a sufficient condition. Leading scholars mention that a solid patent system provides opportunities for firms to overcome Arrow's (1962) 'disclosure problem'. However, there are still significant transaction costs in transferring technologies. Selling technologies in the marketplace is not fully leveraged and according to (Gambardella, Giuri and Luzzi, 2007) the market for technology could be 70% larger if transaction costs could be further reduced. The high percentage of unused but patented inventions could provide a ready supply of technology to the market if these costs could be addressed.

4.2 Open innovation hampered by the high costs of the European IP system

Europe has been working for almost half a century on its IP system (Van Pottelsberghe de la Potterie, 2010). However, the current system remains overly complex, opaque, and unpredictable; and constitutes a heavy financial burden for small companies or start-up companies (Veugelers, 2009).

The European IP system is the most expensive and most complex patent system in the world due to its high level of fragmentation and translation requirements. Moreover, once a patent is granted by the EPO it must be enforced (i.e. translated, validated, and renewed on a yearly basis) by the national jurisdictions of the countries in which the patent is applied. The problems go way beyond the translation costs that have been prominent in recent media accounts. Transaction costs are only one of four types of costs (procedural costs, external costs, maintenance costs, and translation costs) associated with the patent granting and maintenance process. The London Agreement, which intends to reduce the translation requirements for patents when they are validated at national patent offices in 15 out of 34 states, has led to a reduction in the cost of patenting by 20-30% (Van Pottelsberghe de la Potterie & Mejer, 2010). Despite these translation cost savings the relative cost of a European patent validated in six (thirteen) countries is still five (seven) times higher than in the US (Van Pottelsberghe de la Potterie & Mejer, 2010). The high cost of patents in Europe also has a major impact on the number of potential patents that are not submitted (or withdrawn)

because of costs. The difference in price between the US and Europe partly explains why the USPTO attracts four times more patent filings than the EPO (Van Pottelsberghe de la Potterie & Francois, 2009).

> "A unique European patent system would make it practical for small companies and universities to protect their intellectual property. The costs of filing and managing a patent is probably around €50,000. So, a small company could afford to do one of these and so protect the core idea of the company. And that is quite critical. A university spending half a million or a million euros a year on patent protection of IP would probably have the budget. This would encourage the growth of the patent industry that contributes to innovation. Why are Americans so good at things like start-up culture? Because they seek to find a sweet spot between universities who want to have impact and private investors or VC funds who want to make money and IP attorneys. And that builds a community of knowledge that knows what is going on and that just attracts more and more people." *Dr. Andrew Herbert, Chairman, Microsoft Research EMEA*

IP is increasingly embodied in business strategies and an efficient IP system is considered to be crucial in the development of more R&D collaboration and technology transfer between firms. A bold shift towards a better harmonization of the European patent system resulting in the use of a single European patent would drastically reduce the costs and complexity of the current system. As a result, Europe has to make bold steps towards a single EU-patent system as new economic blocks in the world threaten to reduce Europe to a second-tier player in science and technology. However, a single EU-patent needs to be matched to a centralized litigation process via a single court. It is fundamental that this Pan-European Patent Court (known as the European and EU Patent Court or EEUPC) has clear rules of procedure and is run by a highly qualified group of IP judges. This court could function only under these conditions. Otherwise, the perspective of a single patent being invalidated in any one of 27 member states after a trial of variable quality would be a significant step backwards.

Cost is not the only issue. The EPO is currently working to reduce the time to grant a patent (currently 49 months) which compares unfavorably to the JPO (31 months) and the USPTO (27 months).

Open innovation requires a reliable and cost efficient IP system. It is obvious that Europe's IP system must be soon rescued from its major failings in order to stay in the major league of developed economies in which an effective protection of technological breakthroughs is crucial. SMEs and especially young innovative companies suffer from the lack of affordability of patenting in the EU. The introduction of an EU patent would already be a huge step forward (van Pottelsberghe 2010), but more initiatives are necessary to bring costs down to the levels of competing economies such as the US and Japan. Van Pottelsberghe (2010, p. 7) suggests introducing a '50% reduction in entry fees for a well-defined group of young innovative companies up to the sixth year (the average duration of the examination period). A pay-back process (of the 50% reduction) could be scheduled for companies that keep their patents enforced for more than six years.'

Open innovation thus encourages European policy makers to invigorate the European patent system. Therefore, it is interesting to notice that the EU in the last 12 months has made progress on a unified patent system – e.g. results from the European Council meetings of December and February show the Commission is pushing beyond the London protocol towards a reduced-translation system for applications, and is continuing to try to figure a way around a recent Court rejection of earlier attempts to unify the patent courts.

4.3 Aligning incentives of researchers and management in cooperative research with universities

Researchers at universities and labs carrying out research for companies always face tension between the need to publish early and the requirements of the contracting companies to keep inventions secret until a patent is filed. Currently, a patent application will be rejected in Europe if the invention has become publicly available before the patent application was filed. This includes selling the invention, giving a lecture about it, showing it to an investor without a non-disclosure agreement (NDA), publishing it in a scientific journal, etc. America has a one-year grace period. This means that the inventor can freely publish his invention without losing patent rights. This is crucial for the scientists and engineers in universities and research labs who have become an increasingly important source of new ideas for companies that embrace open innovation. The European patent system may benefit from the introduction of a grace period alleviating the tensions between scientists who want to publish as soon as possible –

and companies that are licensing the technology and want to delay publication until a patent is filed. If a grace period was in place as in the US, companies would not have to inhibit any of the internal or external researchers from publishing their research, given that the patent application would be made within a year after the first publication or first conversation with an external individual. Under the current European system, companies must first file a patent and that requirement is a major inhibitor for research collaboration, particularly in fast-moving industries.

> "For example, we once had many huge internal R&D centers oriented towards the mission of the company. These centers had more ability and more capability than most universities. However, they were mostly dismantled in the 1990s because they were increasingly seen as vast costs with uncertain benefits. And, of course, at the same time, governments have been investing in the research system, national labs, and major universities – especially in America. The business case for doing it yourself, rather than working with major universities and the general innovation ecosystem in various countries has became weaker and weaker." *David Ayton, BP´s head of research & technology*

IP discussions between research institutes (or universities) and companies can be one of the most troublesome elements of interactions with academic centers. Most collaboration discussions go very smoothly, but problems can occur if:

- Academic centers over-value their IP and over-estimate the chance of achieving a commercial return, leading to elevated expectations of royalty payments that can make projects untenable; or
- Academic centers attempt to patent their work but do so inappropriately, leading either to a lack of protection in key global markets or – worse still – creating 'prior art' that invalidates patents on more useful developments of the same technology.

These potential collaboration problems in research institutes or universities require professional IP management as discussed in Section 2.

4.4 Activating unused IP in large companies

Large multinational firms have a vast portfolio of patents. To protect their inventions a company such as Philips files, via its Intellectual Property and Standards organization (IP&S), an average of 1600 patent applications annually, owned 55,000 patents in 2009, and employed 500 IP professionals and support staff worldwide. However, as noted above, about 85% of all patents of large companies are never used in new products; or are used to deter potential competitors in a particular technological field that the company considers strategically important. This is an enormous amount of knowledge that is gathering dust in corporate drawers. From a public policy point of view this is a large untapped source of knowledge that could create new companies and economic growth if there were an efficient way to 'activate' these unused patents in other companies.

To be sure, major companies with large patent portfolios can monetize unused technologies. Patents are frequently used as tickets in cross-licensing negotiations (mostly) with other large companies. However, licensing technologies from large companies to small firms; or the setting up of new ventures based on the IP of large companies is not a current practice in most companies. The major reason that large companies do not invest seriously in externalizing internal IP is because it is too problematic dealing with small firms or spin-off ventures. Licensing-out technology or spinning off ventures is a process that requires time and energy. However, the return is likely to be small as SMEs and start-ups generate insufficient revenues to seriously interest a large company that wants to monetize its unused IP.

As a result, there is a huge amount of unused technology in large firms that will not automatically find its way to potential licensees and spin-offs. In our opinion, policy makers can facilitate these transfers through simple policy initiatives. Microsoft, for instance, has established a unit called IP Ventures, which partners with start-ups, venture capitalists, and government agencies to take inventions created by Microsoft Research and put them in the hands of entrepreneurs and small companies. Microsoft is working closely with government economic development agencies such as Enterprise Ireland and the Finnish National Fund for Research and Development (Sitra) to transfer technology and spur the growth of small businesses. Microsoft provides IP to entrepreneurs that would otherwise have gathered dust on the shelves; and the government agencies offer managerial, marketing, and financial support of various kinds (Gutierrez, 2008).

4.5 Large scale technology collaboration and IP agreements

IP transfers can take more complex forms than bilateral agreements between two organizations. The growing complexity of technologies and the increasing need to collaborate with different types of partners to develop and commercialize a product is forcing companies to team up with various types of partners in broad consortia. Examples include the IIAP programs of IMEC, CTMM, and IMI. In IMEC's Industrial Affiliation Programs, IMEC invites partners to collaborate on precompetitive research on nano-electronics and uses the so-called fingerprint IP-model to deal with background IP in collaborative research and IP-ownership and the use of jointly developed technologies (Odusanya et al. 2009; Vanhelleputte and Reid, 2004). The Centre for Translational Molecular Medicine (CTMM) develops medical technologies that enable the design of new and 'personalized' treatments for the main causes of mortality and diminished quality of life (cancer and cardiovascular diseases and, to a lesser extent, neurodegenerative and infectious/autoimmune diseases) and the rapid transfer of these treatments to patients. It is a public-private consortium that comprises universities, academic medical centers, medical technology firms, and chemical and pharmaceutical companies. CTMM is using a similar open IP model as IMEC to distribute the benefits of the joint research among the participants (including those that cannot generate patents such as hospitals).

The Innovative Medicines Initiative (IMI) is a partnership between the European Union and the European Federation of Pharmaceutical Industries and Associations (EFPIA). The aim of IMI is to support the faster discovery and development of better medicines for patients and to enhance Europe's competitiveness by ensuring that its biopharmaceutical sector remains dynamic. Participants in the IMI (research institutes, SMEs, and large pharmaceutical companies) generate IP which is owned by the participant(s) who generated it (or when no individual participant can be identified the IP is jointly owned by those participants who have carried out the work). Participants have access to the knowledge developed in IMI before completion of the project and they have access to IP for research purposes after the project. Beyond the research, participants may use, sublicense, or commercialize the foreground they own.

These complex governance forms of joint research require careful thinking about ownership and the use of commonly developed IP. The pressure on universities to generate revenues from their research can exacerbate problems in some IP negotiations. In the IMI, for example, competing pharmaceutical companies are happy for the results of pre-competitive research to be made freely available, but some technology transfer offices in potentially participating universities want ownership over any IP generated by their work. The idea of academic centers being worried about appropriating returns, while the industry is happy for free access, runs counter to many public expectations, but represents an important trend. These complex forms of multi-partner collaboration are shaping the future of European research; therefore, it is desirable that policy makers help in shaping/standardizing collaborative IP rules based on good practices. The current FP7 IP rules are not adapted to these complex forms of collaboration.

4.6 Opening broader channels of collaboration

Open business models have proven to be very effective in different industries. In many cases, firms with considerable IP assets have decided to open specific parts of their IP portfolio and share more IP with communities of practitioners or users. For example, IBM's IP Collaborative Innovation initiative pledged 500 patents to open source communities, launched an Open Innovation Network, and established an American university summit for open collaboration. Similarly, Sony and Nokia have decided to share a portion of their patent portfolio to stimulate innovation in green technologies. Another successful collaboration is the GreenXchange; a breakthrough concept for sharing IP among companies that are working on sustainability issues in the footwear sector.

In a similar effort, Microsoft has recently decided to build a bridge of collaboration to the open source world to improve the interoperability of their products. Microsoft is increasingly cooperating with major Linux providers to enhance the interoperability of Windows and Linux software through joint technology development. As customers want to use both systems to work together seamlessly and efficiently, Microsoft and Novell created an IP bridge between the worlds of open source and proprietary software, respecting each other's innovations and those of the open source community.

Policy makers should study in detail these strategic partnerships in which open and proprietary software can be aligned and combined in order to diffuse this type of agreement in other industries where lack of interoperability is still a major problem from the customer's point of view.

4.7 Promoting intermediaries to facilitate the diffusion of knowledge

Recently a new form of third party, called innovation intermediaries, has emerged in Europe and around the world. NineSigma, InnoCentive, Yet2.com, YourEncore are just a few of the 45 innovation intermediaries we listed in 2010. These intermediaries facilitate collaboration across technology markets by providing innovation platforms that link companies with potential innovation solvers, and improve communication within different parts of the system by facilitating the diffusion of knowledge or technologies.

There are significant transaction costs in transferring technologies. Selling technologies in the marketplace is not fully leveraged and according to (Gambardella, Giuri & Luzzi; 2007) the market for technology could be 70% larger if transaction costs were reduced. Intermediaries are shaping the market for technologies and their operations help to make the market for knowledge and IP more transparent. Therefore, we recommend that policy makers in the European Union reflect on how collaboration with different established innovation intermediaries can help spread scientific and technological knowledge, and develop technologies and patents. Innovation intermediaries have been mainly focused on (major) companies as clients, but there is an enormous potential for using their expertise to solve problems for universities, research labs, and SMEs. These potential clients cannot currently afford the services of these innovation intermediaries and so policy makers could analyze how costs could be lowered to an acceptable level for these groups.

Similarly, universities and research labs could work more effectively as solution providers. So far only a few universities have developed a strategy to participate effectively as solution providers. Finally, publicly funded institutes that generate IP are not usually involved in IP-trading and IP-auctions. It would be interesting to analyze how the technology of European universities and research labs could be sold or licensed as part of their overall valorization strategy.

4.8 Extending the IP scope beyond patents

Patents are only one form of IP protection and are very good for protecting IP that is related to a broad range of technologies. For instance, in the pharmaceutical industry patents are usually used for protecting the molecular structures of medicines. However, the pharmaceutical industry has always sold more than just chemicals: pharmaceutical companies sell chemicals plus knowledge about how these medicines can and should be used. The knowledge is generated in clinical trials, which now account for around 60% of the R&D costs (up from 50% a decade or so ago). Moreover, drug manufacturers are being asked for ever greater amounts of data by regulators and reimbursement agencies, and this data is costly to produce. Data Exclusivity (DE) is another important form of IP protection for pharmaceutical companies and is generating incentives for companies to collect data (particularly clinical data) on a medicine to investigate its value in treating new indications. Hence, it is important in the context of open innovation that policy makers pay attention to the increasing heterogeneity of data/information in the light of IPR policy.

Similarly, trademarks, copyrights, and industrial design rights are important in the discussion of an open innovation policy. The emergence of the internet is changing and will continue to change the business models that are used in many service industries (Chesbrough, 2011). Policy measures can have a considerable impact on the speed and direction of these changes – as we have seen in the music industry – but the European Commission could play a major role in proactively shaping the conditions for business model changes in several services industries that rely on these types of IP protection.

5. Promoting cooperation and competition

Open innovation can only prosper when policy makers avoid monopoly and promote rivalry within the economy. If market competition is strong within an industry, firms will be motivated to find ways to exploit their ideas as fully as possible. If market leaders are in a position where they can enforce monopolies in their product markets, then the open innovation process can easily break down. Monopolistic firms could attempt to hoard their ideas and technologies and exclude them from rivals. In the process, other ways of using these ideas in society could also be thwarted. In an open innovation era, a narrow focus of policy measures for large companies is no longer effective. Policy makers must focus on the innovation ecosystem and pay more attention to start-ups and SMEs.

5.1 The locus of innovation is in the network

In an attempt to spur open innovation, policy makers should resist the temptation to rely primarily upon the largest companies to lead innovation efforts. Such a reliance on large companies is a remnant of the closed innovation paradigm, in which industrial giants with large corporate R&D labs were pioneering the technological frontier. Nowadays, knowledge is abundant and the technology landscape is increasingly scattered. Therefore, policy makers have to shift their policy support from single, large companies to the innovation system or ecosystem that is creating and commercializing technologies. This implies that policy makers have to look at the different nodes in the 'food chain' from science to commercially viable product introductions. Innovation policy can play a crucial role in stimulating particular innovation systems in which universities, research labs, start-ups, and large companies jointly create new market opportunities. The locus of innovation is no longer in the firm but in the network (Powell et al, 1997). An analogous shift in policy making should redirect the policy focus from single large companies towards networks or ecosystems in which innovation partners jointly create new business opportunities.

Pharmaceutical companies for instance experience quick changes in their innovation process. In recent years, the productivity of pharmaceutical R&D has declined. Attrition rates in development have remained high. At the same time, spending has increased to cover the increasing demands for clinical data from regulators and payers. As a response to declining research productivity, these companies have adapted their R&D organizations in an attempt to meet these productivity challenges. More and more stages of the R&D process are being undertaken through collaboration or out-sourcing. At the research level, companies deploy many different models for creating effective collaborations: contractual research agreements for specific research tasks; bilateral agreements with individual universities and research groups; collaborations with other companies on areas of pre-competitive research; bi-lateral agreements with other companies to progress specific research areas or specific high-cost development projects. Some companies have a venture fund and external research experts dedicated to finding partners and generating new deals and collaborations.

5.2 SME formation and growth

This policy shift also implies that innovation public policy should seek to cultivate and strengthen small and medium sized firms. Their vitality will infuse a greater dynamism into the economy, as those companies that survive will embody new combinations of knowledge, and new business models to commercialize that knowledge. These companies will also spur greater innovation effort from larger companies. They provide large companies with demonstrations of the commercial viability of new approaches to commercializing ideas, and their success confronts incumbent firms with hard facts that they ignore at their peril. Incumbents will respond to the demonstrated success of new firms with new combinations of knowledge far more rapidly than they will respond to any direct government program targeted to support them. Start-ups often have new technologies or are highly creative in creating new business models to commercialize knowledge; therefore, they are also great sources for large companies to in-source new technologies and business models for commercializing technologies

To spur open innovation, policy makers should facilitate the creation of start-ups and encourage entrepreneurship in the European economy. Policy makers must also facilitate cooperation between SMEs and large companies to discover new knowledge about the functioning of technologies and enact new technological ecosystems as system integrators. Finally, a new breed of managers is needed in large companies with the skills to set up and develop new ventures such as spin-offs based on unused but patented technologies.

European VC-backed ventures should be able to grow into full developed businesses that can compete on an international or global scale. There should be different financing schemes all the way from seed to late stage; otherwise too many European high-tech ventures will be acquired by large American and Chinese companies. If there is sufficient money available in the VCF market then start-ups can develop new manufacturing and distribution assets (see Section 3). In the biotech and pharmaceutical industries, running phase three of clinical trials costs €30-60,000 and scaling up manufacturing and launching a product can cost €50-100 million. However, in a second reoffering on the stock market, start-ups can raise €200 million, produce the drug themselves, and grow with revenues of €200-500 million a year. Genzyme and a range of other start-ups grew just this way. Moreover, start-ups can always subcontract some operations if necessary.

The composition of the boards of directors also plays a role in stimulating high-tech start-ups. There should be directors on the board who know the industry very well. In Europe, executives from large companies do not usually want to 'waste their time' being board members in small companies. However, large companies that do encourage their directors to sit on small boards (such as Microsoft, Novartis, GE, BP, Pfizer and DSM) generate two effects. Firstly, board membership gives early access to new technologies with considerable business opportunities. Secondly, the directors bring their experience to the start-up company. Let's take, for instance, the Novartis venture fund. When Novartis invests in start-ups it shares its views on the industry with the start-up, and brings a great deal of expertise from the pharmaceutical industry. This is of enormous value for the start-up because, while a small company may have vision and new technologies, it will probably also lack many managerial skills necessary to avoid obvious mistakes. A good composition of the board of directors significantly increases the economic viability of start-ups. Governments should incentivise large companies to encourage their directors to become board members in start-ups.

Finally, the way in which VCs are managed is very important. In America, VCFs are mostly managed by former entrepreneurs and former executives of large technology companies who have become investors. This approach is the right way to do it. Growing new ventures is not about how to analyze profit and loss accounts – investors have to know the field, the technology, and understand the value proposition that will create competitive advantage for the venture. The background of the people who manage a venture capital fund is critical. Too often in Europe venture capital firms are headed by people with a financial background, and zero experience in industry or academia. Consequently, there is a high risk of making mistakes or making overly conservative decisions – creating followers instead of leading ventures. Therefore, it would be good in Europe to stimulate the formation of independent VCs that are led by people with a strong research, clinical, or industrial background. How can we stimulate that? The EC could, for example, launch a program through the European Investment Fund to stimulate the creation of new partnerships. It could invest in new VCs as long as there is a new team with an international background leading the venture.

6. Expanding open government

Governments are the owners of the largest databases in the world with unprecedented possibilities for new and functional technologies and information for commercial and other uses. To establish a transparent, accountable, and innovative management system, governments are transforming their public services into more open, accessible, and collaborative structures. Several countries initiated what is often referred as 'Open Government'. However this revolution in the public sector primarily achieved worldwide attention after President Obama's Memorandum on Transparency and Open Government in 2009.

The open government initiative is a robust framework for the transformation of government agencies. It involves various activities ranging from interactive policymaking with citizens to proactive disclosure of government data. It also improves informational inputs into markets for public services and enables co-production of public services (Fung and Weil, 2010). Thus open government initiatives promote a new way of viewing the role of government and citizens.

However, the most powerful information sources are nowadays not in the hands of the governments, but in hands of large corporations like Google (De Jong et al., 2008). The rapidly growing global distribution of information via internet is an important driver of open innovation. But the uncontrolled growth of online knowledge repositories can also hamper open innovation. Easy access to these repositories is considered critical to open innovation. Thus governments have to be vigilant and monitor the evolution of online repositories to ensure that private companies do not have a monopoly over information that is useful for society.

6.1 Open government and open data

Recently, there have been several 'open data' initiatives in Europe promoting interactive sharing of information between the government and the public. Open data refers to a practice of making data freely available online in a standard and re-useable format for everyone to use (Fung and Weil, 2010). City halls collect extensive data about residents and the city. 'Data' in this case refers to everything from statistics to election results, to the location of schools or parking lots.

As governments realize the benefits of opening their data, open data has emerged as an essential movement across the world. Publishing government data to bring more transparency and greater public participation to government is neither purely an American idea nor new. Many local and national governments have created their own 'data portals' to list data (such as 'data.gov.uk' in the United Kingdom). These open data portals allow citizens to access all public information obtained during public affairs management in standard and re-useable formats. Thus open data is the key foundation of an open government initiative.

The social benefits of open government vary from citizen engagement to increased transparency and accountability, or enhanced communication channels. For instance, citizens gain greater insights into how their taxes are spent. As governments foster the availability of information for citizens and help them to become better informed, transparency about government decisions and practices is improved, and much more knowledge can be created in a distributed way by citizens or organizations that deliver new or improved services based on the large databases opened by the government. Real time availability of information also increases the potential to create extra services (Fung and Weil, 2010).

Other than the social aspects of this progress, open government also supports public sector innovation through diminishing bureaucracy and friction in data exchange and demolishing competitive advantages gained by proprietary access to data. Innovation is most likely to occur when data is available online in open, structured, computer-friendly formats for anyone to download (Robinson, et al, 2009). Excellent examples include the USPTO/EPO databases about patents that are applied for and issued in the US and Europe respectively. These databases have been used by thousands of researchers and have advanced our understanding of the role of innovation in creating competitive advantage at the firm level and wealth creation at the macro-economic level. As a result, open government encourages new ways of interaction between government and public.

To foster innovation, government entities often use 'contests' to encourage citizens to collaborate. Apps contests are common (such as 'Apps for Democracy') around the world to build web applications and services with open data. Government agencies also launch challenges such as Challenge.gov or NASA Centennial Challenges Program in the United States for citizens to provide and share their solutions and innovations with the government.

Therefore, open data is crucial for innovation because developers use government data to build novel applications.

Contests are not the only platform for government organizations to spur collaborative innovation with the public. Other platforms for communication include 'Blue Button,' an online health portal where people can download their health information securely and privately; or 'Federal Register 2.0,' an attempt to organize articles into news sections for readers to browse by topic and by government agency, and which enables citizens to submit comments on regulatory actions. In addition to transparency and accountability intentions, governments use open data initiatives to encourage the development of novel solutions to public issues through innovations in the use of public knowledge.

Open government and open data are fundamental approaches for cities to generate more value for their citizens. Since government data is important for both government and citizens, a clear policy on how governments should open and distribute their data is required. Open data projects use the following principles: data should be complete, original, available online (such as in HTTP format), or in structured formats such as XML, uniquely addressable, machine readable, and license free without limitation for anyone or anything, and offered in a timely manner (Robinson et al., 2009). Furthermore, governments should develop a central online portal so that data can be browsed and downloaded by citizens. There should also be a commitment by the government to regularly update data.

To be useful, open data projects require more than just accessible data. Both government and citizens involved in open data projects should pay attention to each other and be committed. Governments should open data, but citizens should also be committed to make use of this data and innovate. Thus governments should provide technological support and marketing to promote citizen engagement.

There remain a number of areas where details must be worked out. Much government data is dispersed and some information is still not fully disclosed. Deciding which data should be published is an important decision. Today many politicians strongly believe in the public's right to access all information – even information that is directly related to national security and privacy issues. To accomplish this, there are certain guidelines for how to ensure disclosure while protecting national security and individual privacy (Swartz, 2010). Thus

governments should strike a balance between the requirements of openness and considerations calling for non-disclosure.

6.2 Extending the idea of open government

The idea of open government can be extended to areas where the government is a monopolist. Public procurement drives demand innovative goods and services – as analyzed previously in the Aho report (2006). Examples where public purchases play a crucial role in driving top technology are defense, aerospace, road and railway infrastructure, and specific ICT applications. These purchases of innovative products encourage suppliers to generate top-technologies that also represent interesting but untapped sources of innovations in commercial applications. There are numerous examples of how military technologies can successfully lead to commercial applications. The same holds for aerospace technology, which even leads to new products in low-tech industries – see, for example, Quilts of Denmark's functional quilts (Vanhaverbeke and Bakici, 2010).

However, the commercialization of technologies developed in these industries does not come automatically. On the contrary, companies that develop high-tech products for governments usually have priorities and capabilities other than those required to develop commercial products. Leading companies in these industries are not usually involved in the development of commercial applications. Usually, other types of organizations champion the development of the commercial uses of military or aerospace technologies. A few examples include MILCOM Technologies (now part of Arsenal Venture Partners) and (the early) Qinetic. Both organizations search for interesting technologies that have been developed originally for military purposes and turn them into commercial applications through licensing deals or new ventures.

With the 1958 National Aeronautics and Space Act, American federal agencies such as NASA are required to facilitate the transfer of technology to the private and public sector for business and other applications that generate a common benefit. NASA has established 1700 spin-offs and has organized itself to actively pursue market opportunities. The transfer, application, and commercialization of NASA-funded technology occurs in many ways – knowledge sharing, technical assistance, intellectual property licensing, cooperative research and technology projects, and other forms of partnership (such as the NASA Open Government

Plan). Similarly, the Space Foundation is a national non-profit organization in the US that is certifying products that originate from space-related technology or use space-derived resources for consumer benefit.

Governments can further stimulate the commercialization of these technologies through funding. In the US, the Small Business Innovative Research (SBIR) program distributes $2.5 billion per year in R&D grants across 11 federal agencies, including $1.2 billion distributed by the Department of Defense. Companies whose products have high transition potential are eligible for 'commercialization' funding.

6.3 Conclusion

To encourage collaboration and innovation, the old top-down model of government data management must be changed into a networked model. The scope of open data should also be expanded. Publishing data in bulk must be a government's first priority as an information provider. By publishing data in a form that is free, open, and reusable, governments will empower many innovative ideas. However, the provision of data alone will not lead to the goals of open government. Governments need to design effective legislation and policies to support this collaborative approach with citizens. Data must be processed and an open government ecosystem should be created. Open government, if implemented effectively, can improve the accountability of government, as well as boosting innovation in and beyond the public sector.

Public policy makers can also play a role in encouraging the commercialization of technologies that have been developed in industries where the government is the sole customer. Examples include the defense industry, aerospace, road and railway infrastructure, and national security. Many of these technologies have the potential to be commercialized; but this does not happen automatically. The development of commercial applications for these technologies requires the help of specific organizations that are specialized in detecting and developing commercial applications. Governments should look at good practices and accelerate the search for commercial applications for these captive technologies.

7. Summary of policy recommendations

Many past and present innovation policies stem from a logic that is reminiscent of a closed innovation mindset. These may have been appropriate a generation ago, but are no longer appropriate to the innovation needs of the EU in the 21st century. Instead, an open innovation mindset is required:

Closed innovation mindset policies	***Open innovation mindset policies***
Focus on developing a large domestic/European market.	Pursue global market opportunities.
Protect European companies from foreign innovators.	Invite external innovators in to spur greater competition and innovation.
Limit the number of foreign students and workers in Europe.	Encourage circulation of ideas by inviting foreigners to study and work in Europe, while also sending Europeans overseas.
Give subsidies and credits to the largest European firms to keep them innovating in their home country.	Provide the proper institutional structures for innovation and focus on SMEs.
Ensure that government funds go to domestic/European firms and avoid assistance to foreign companies.	Use government funds to stimulate greater SME formation and expansion, encourage innovation investments (whether by foreign or domestic companies) within the EU, and support export industry activities.

Specific recommendations – we have summarized our recommendations in four areas:

1. Education and human capital development and diffusion
2. Promoting competition and rivalry
3. A balanced approach to intellectual property
4. Expanding open government

1. Education and human capital development

The EU is fortunate to have tremendous human capital resources at its disposal. Nonetheless there are some important changes to be made that would strengthen the excellence of research that emanates from this pool of human capital.

Increase meritocracy in research funding – too many research programs within the EU sprinkle money across all the member states, with insufficient competition for these resources. The result is politically popular, but economically, the funded programs lack the excellence and scale to produce world class research and technology. Research funding competitions should move to the EU-level wherever possible, to reward excellence and promote the promising ideas of new scholars.

Support enhanced mobility during graduate training – EU graduate training is world class in some fields in some countries, but not in others. While this condition will not change quickly, individual researchers can be given world class training if they are supported in conducting part of their training outside the EU and at the world's leading centers. In turn, EU graduate schools can broaden training by inviting the most promising scholars from outside the EU.

2. Financing open innovation: the funding chain

Funding open innovation requires a broader set of funding tools, reflecting the different financial needs at each stage of the process in which new ideas move from research and development into full commercial exploitation.

Introduce the funding chain concept: Growing ideas into profitable businesses requires appropriate types of funding at each stage of the development and commercialization phase. A narrow focus on public subsidies for R&D inputs by firms is not in accordance with open innovation.

Increase the pool of funds available for VC investment: The availability of VC funding is crucial to oil the innovation engine based on the establishment and growth of new ventures. Europe's VC market is dwarfed by the American market and this fact is slowing the growth and dynamism of the European economy.

Support the formation of university spin-offs to commercialize research discoveries: Great technical ideas do not get commercialized because they are too risky to be privately funded.

Reflection is needed on how policy can help early-stage ventures with financial problems cross 'Death Valley'.

3. A balanced approach to intellectual property

One of the most powerful levers government has to stimulate innovation is to design intellectual property policies that reward innovative initiatives while also stimulating the diffusion of innovations throughout society.

Reduce transaction costs for intellectual property. Current IP policy is anchored in each member country of the EU, fostering multiple filings, multiple language translations, and creating much high costs for EU patents. We need to move to a single EU patent, backed by a unified judicial process, to lower the costs of patent protection to those of rival regions. Current costs are particularly onerous for SMEs.

Foster the growth of IP intermediaries. There is a growing market for IP, and the EU should encourage the expansion of this market. In addition, it should fund research into the functioning of IP markets so that future policy can be based on new and better evidence.

Rebalance EU policy towards universities with publicly funded research. Too many universities are focused on maximizing the royalty income they receive from publicly funded research. A more balanced approach would be to give greater weight to the social impact of publicly funded research, with particular emphasis on broadly diffusing research within society.

4. Promoting cooperation, competition, and rivalry

Competition is vitally important to innovation. It enhances the willingness of firms to take the risks that advance new thinking, new processes, and new markets in an innovative society.

Abandon policies to support national champions, and shift support to SMEs. SMEs are powerful agents of innovation diffusion within a society. Even when large firms remain at the top, the presence of striving SME firms in their industries forces large firms to innovate more rapidly to keep ahead. Policies should support SME formation, expansion, and exports outside the EU.

Promote spinoffs from large companies and universities. Many innovative ideas start small, too small to be of interest to large companies. Many other ideas start inside a university lab,

but require risk capital and entrepreneurial management to move into the market. Government can help facilitate these spin-offs by facilitating the transfer of IP to these spin-offs (perhaps providing tax incentives for large companies) and supporting the invested risk capital.

Focus on innovation networks. The locus of innovation is no longer in single large companies; but in innovation networks in which a mix of innovation partners are involved: universities, research labs, start-up companies, large multinationals, and governments. The relationship between these players largely determines the overall performance of an innovation system. The success of large firms hinges increasingly on their ecosystem.

5. Expanding open government

Government is not a bystander in the innovation system. It possesses a wealth of information distributed through a myriad number of databases that are often difficult to access. Government also buys innovation from many suppliers in society, and its opportunities to foster innovation through its procurement activities also deserve more attention.

Accelerate the publication of government data wherever possible. Citizens and companies can often spot wonderful innovation opportunities if given the necessary information. This has already been demonstrated through mashing data from different sources, and developing applications to analyze and interpret public data.

Utilize open innovation in government procurement. When buying new technologies, create and employ open innovation intermediaries to seek out solutions from anywhere in the world, vs. the usual suppliers to the government. The U.S. Department of Homeland Security, for example, has created a government organization, SECURE, to procure defense and security-related technologies using open innovation.

Foster commercial application of technologies developed for the government. Public policy makers should encourage the commercialization of technologies that have been developed for military, aerospace, road and railway infrastructure, national security, etc. Many of these technologies can be turned into interesting commercial applications, but this process will not happen automatically without government incentives.

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