

**Broadcast Search via Open Innovation Intermediaries:
Multi-Method Research on Organizational Success
Factors**

Der Fakultät fuer Wirtschaftswissenschaften der Rheinisch-Westfaelischen Technischen
Hochschule Aachen vorgelegte Dissertation zur Erlangung des akademischen Grades eines
Doktors der Wirtschafts-und Sozialwissenschaften

von

Andreas M. Zynga

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Executive Summary

Open innovation represents a paradigm shift from the traditional “closed innovation” where internal R&D activities lead to internally developed products. Open innovation is the practice of problem solving by looking beyond companies’ boundaries to the outside world and its experiences and discoveries as part of the innovation process, instead of relying exclusively on the internal skills of one’s own researchers and developers. The emergence of an “open innovation marketplace” has enabled a systematic, efficient, and accelerated method for companies to gain access to external technologies and expertise. Such marketplaces are usually run by intermediaries – specialized firms that provide professional knowledge search expertise to companies seeking knowledge or innovations through pertinent technological infrastructure and a vast community of solution providers. Although scholars have comprehensively investigated several aspects of the open innovation marketplace, relatively little attention has been paid so far to organizational success factors with respect to both the innovation seeking firm and the intermediary. There is a research gap in identifying the specific organizational capabilities, and particularly their sequence of adoption at the innovation seeking company when going from “no open innovation” to “intensive use of open innovation”. There is also a clear gap in the research on intermediaries and their role in the overall success of broadcast search. The goal of this research project is to identify the variables of success and provide a framework to implement open innovation, more specifically, the intermediated broadcast search method, with higher rates of success. To that end, in Part A of this thesis, a comprehensive introduction to the research field is given. The introduction includes an overview of the open innovation marketplace and the broadcast search method facilitated by intermediaries. Moreover, the theoretical background which forms the basis of the three research papers in Part B of this thesis is presented. Each of the research papers examines distinct aspects of success with open innovation from different perspectives— a brief outline of the research papers is given below.

Research Paper I identifies the organizational success factors that lead some innovation seeking companies to be more successful at deriving value from their interactions with intermediaries than others. It turns out that the difference in success rates from intermediated broadcast search is partly linked to the actions innovators take internally to add to their value capturing potential. This paper focuses on what innovating companies can do internally i.e. a specific set of actions that innovating companies can take at the very beginning of their external knowledge searching, to increase the likelihood of success when engaging with intermediaries. This exploratory research, based on interviews and surveys among NineSigma clients, identifies

several routes to improving the chances of success when engaging in broadcast search: Optimizing the RFP writing process; rewarding solution providers that add value to internal problem-solving; appointing an experienced, high-profile open innovation champion to stimulate external knowledge searches; prioritizing open innovation projects and allocating long-term funding to these initiatives.

Research Paper II, by means of both quantitative and qualitative methods, shows that intermediary organizations, under extant market pressures, strive to improve their interactions with both sides of their two sided market – the innovation seeking company and the solution providers. Intermediaries continuously evolve their business model with respect to pricing as well as service processes. Specifically, at NineSigma, pricing changes such as raising the project fee in favor of dropping the transaction fee altogether, and service process changes to include more care for and many more touch points with solution providers and accelerated proposal evaluation processes, have led to increase in client satisfaction, improvement in the quality and quantity of solution proposals received from solution providers, and higher deal closure rates.

Research paper III identifies the management capabilities essential for implementing open innovation and lays out a sequence in which companies build these organizational capabilities. The paper, building on the theory of change management, shows that it is not imperative that companies build all capabilities – many of which require intensive organizational changes involving a multitude of stakeholders – right at the start of introducing and implementing open innovation. The findings suggest that companies take the “path of least resistance” when implementing open innovation as an organizational management method. Companies typically start with using the services of intermediaries and tech scouts to access global knowledge. Only after the organization has had experience with these initial projects, it moves on to further refining the open innovation process by building additional capabilities such as internal processes to encourage knowledge creation, sharing and utilization within and outside firm boundaries; broadening and efficiently managing its external networks comprised of known entities external to the organization; further increasing its access to global knowledge by joining consortia and other collaborative activities; and building capabilities directed toward efficiently leveraging external knowledge and integrating it into the internal R&D activities.

Overall, this research project answers the following central research questions:

- A. What do innovating firms using intermediaries do in order to improve their success with broadcast search?

- B. How does business model (process) innovation at intermediaries drive success for the different sides of the two sided market model of an intermediary?
- C. Which management capabilities and in what sequence do companies build for successful and sustainable implementation of open innovation?

In the three research papers, answers to each of these research questions are given. It is shown that open innovation is a management method that requires organizational changes and carefully designed change management processes at the innovating company, and the intermediary itself makes important contributions through service quality adjustments that can lead to long-term success with open innovation over time.

Thesis Structure Overview

This thesis consists of two parts. In the first part, an overview of the research field is given, including an introduction to the open innovation market, the theoretical background that forms the foundation of the dissertation project, the outline of the guiding research questions and the corresponding research papers. This part concludes with a general discussion. The second part consists of three research papers which focus on the examination of organizational success factors for successful and sustainable open innovation. Two of these research papers have been presented at academic conferences and one has been accepted for presentation. Since these are stand-alone research papers, some repetitions and similarities are unavoidable.

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Part A.
Introduction to the Research
Field

1. Introduction

In today's knowledge-based economy, innovation is the key for a company to maintain and improve its competitive position, as well as to grow into new areas. Managing the process of innovation is therefore critical in order for a company to sustain and advance its business. The traditional paradigm of "Closed Innovation" wherein companies generate their own ideas and then develop them, build them and market them on their own, is shifting to more "Open Innovation" (Chesbrough, 2003). Open innovation is the practice of problem solving by looking beyond companies' boundaries to the outside world and its experiences and discoveries as part of a systematic innovation process, instead of relying exclusively on the internal skills of one's own researchers and developers (Wagner and Piller, 2012).

A systematic, efficient, and accelerated method of gaining access to external technologies and expertise has emerged since about the year 2000 (Diener and Piller, 2013) with the creation of "open innovation marketplaces". Such marketplaces are usually run by intermediaries – specialized firms that provide professional knowledge search expertise to companies seeking knowledge or innovations. They do this by applying pertinent technological infrastructure on one hand, while accessing a community of solution providers – scientists and experts from industry, academia, and research institutes from around the world (Roijsackers et al., 2014) to provide solutions to companies seeking innovations. The main stakeholders in the open innovation market are thus: 1. Innovation seekers with technical needs; 2. Intermediaries (also called *innomediaries* in this paper because of their role in *innovation mediation*). – organizations helping innovation seekers to source external knowledge; and 3. innovation communities (pools of participants) of the intermediary – the potential solution providers. Intermediaries thus operate as platform providers that enable interaction between two networks – the innovation seekers and the solution providers; thereby operating under a two-sided market model (Rochet and Tirole, 2003).

The role of the intermediary is more than that of a mere "technology broker". It has been widely acknowledged that innovation intermediaries play an important role in developing, accelerating, and controlling the knowledge and dynamic competences necessary to solve complex innovation problems, and in fostering the diverse linkages between various geographically dispersed entities or innovation networks (Howells, 2006; Boudreau and Lakhani, 2009; Luettgens et al., 2012; Roijsackers et al., 2014). The services of an intermediary span multiple areas of the innovation value chain. The intermediary facilitates the entire process of

external technology searching that ranges from need articulation, to problem broadcast, filtering and mapping of solutions, to final negotiations, deal making, and IP management (Roijakkers et al., 2014).

NineSigma, the intermediary contributing data and research focus to this thesis, has been active in the open innovation market for more than a decade. Founded by Prof. Dr. Mehran Mehregany in 2000, NineSigma addresses technological challenges through internet-enabled global open broadcast searches and connectivity. NineSigma was founded on the premise that industry needed an effective means for broadcasting corporate technical needs to potential solution providers to stay ahead of the technology curve, similar to the methods employed by the U.S. Government research group, DARPA. NineSigma has an open innovation network of more than 2 million solution providers, and has done in excess of 3000 technology searches so far. NineSigma created a technology search process that has been continuously evolving over the years through practical insights gained from numerous search successes and failures, as well as the impact this had on its business.

NineSigma's original business model was loosely modelled on the DARPA technology search archetype: A team of interdisciplinary Ph.D.'s would translate a specific technology need from a requesting party (at DARPA: Federal United States Agencies; at NineSigma: Clients; collectively: "Innovation Seekers") into a Request for Proposal (RFP), search for suitable Solution Providers across different industries, and then provide solution proposal packages to the Innovation Seekers. This archetype represents a two-sided market model, with Innovation Seekers on one side, and Solution Providers on the other side. In the early days, when the market for intermediaries practicing systematic open innovation was relatively new, competitive pressures were low, and the only requirement for intermediaries was to provide a consistent and high quality of services. As open innovation started gaining popularity, more organizations started utilizing the services of intermediaries, the number of new market entrants increased, and there was an increasing external pressure to improve search success, and to provide additional service elements that respond to needs of each side of the network. Such market pressures have led NineSigma to evolve its two sided business model with respect to pricing (Eisenmann et al, 2006), but importantly also with respect to service quality / internal organization.

Some companies using open innovation are more successful at deriving value from their efforts than others. These differences are linked partly to the presence of certain management capabilities for efficiently leveraging external knowledge and integrating it into the internal R&D

activities (Chiaroni et al., 2011; Foss et al., 2011; Salge et al., 2012), and partly to the actions innovating companies take internally that enable them to interact more productively with intermediaries, thereby adding to their value capturing potential (Roijsackers et al., 2014).

Thus, successful and sustainable open innovation viewed over a longer time frame requires organizational changes at both the part of the intermediary, as well as at the innovating company. This thesis clearly identifies such changes at both the intermediary as well as the innovating company by means of qualitative and quantitative analyses, and as a result shows organizational success factors for successful and sustainable implementation of open innovation using the example of broadcast search.

Part A of this thesis provides an overview of the research field, including motivation and research project outline, and a description of the management system and market for the broadcast search method of open innovation. Building on that, research gaps are identified, and we then show how the three research papers developed during the course of this research work address those gaps. Subsequently, the three research papers, included in Part B, are summarized briefly, followed by a general discussion and conclusion. A more detailed outline of the dissertation follows in Section 1.2.

1.1. Motivation

As the CEO of NineSigma – one of the most experienced open innovation intermediaries globally – I have been actively involved in hundreds of intermediated broadcast search projects for over 7 years. I also have frequent dialog with open innovation practitioners, and NineSigma has a host of data that help to answer which variables have the most influence on success, and in which way they can be leveraged to influence success.

Despite the growing body of literature on intermediated broadcast search relatively little has been done so far to show what specific organizational factors affect success with broadcast search in order to improve success rates with this method of open innovation. I see that many clients still struggle with the implementation of open innovation as a part of their management system. There is clearly a research gap in identifying the specific process and structural changes the innovation seeking company should take when going from “novice” to successful practitioner of open innovation in a stepwise fashion, both when using intermediaries as well as without external help.

I also noticed there is gap in literature where the intermediary itself is assumed to be a static “black box”, but I know how NineSigma changed organizationally over the years in order to improve search success for all stakeholders. I felt this “black box” needed to be opened in order to contribute to science insight into organizational factors through which the intermediary itself influences success with broadcast search.

With this doctoral thesis I aim to close the research gaps I found, thereby giving academia and practitioners the framework to better apply broadcast search with higher rates of success. This will create value for all stakeholders in the open innovation market, as well as the growing amount of open innovation research projects.

The next section provides an overview of the dissertation project in general and on how I address the research gaps in particular.

1.2.Thesis Outline

The focus of this dissertation is on establishing the different organizational variables that influence success in broadcast search when using intermediaries (Figure A.1).

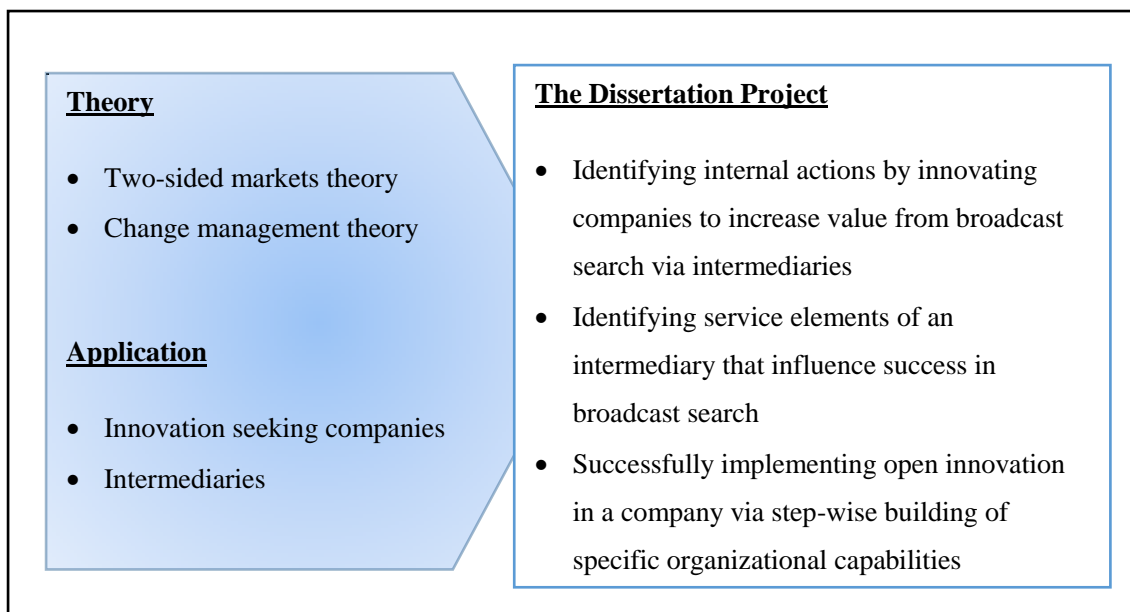


Figure A.1. Structure of the dissertation project.

Underlying theoretical concepts used in this study are the two-sided market theory (Rochet and Tirole, 2003) and theories on managing change and organizational learning in established organizations (Kotter 1995; Judson, 1991). The audience of this research is firstly companies that want to adopt the broadcast search method using intermediaries as part of their open innovation initiative. Secondly, this study also applies to the numerous intermediary organizations that want to improve their success rates with broadcast search.

The structure of this dissertation is as follows. Chapter 2 is devoted to the management system and the market of the intermediated broadcast search method of open innovation which inspired all papers presented here. That Chapter provides general background information on broadcast search and explains how it has evolved to become a management system, and not just another open innovation tool. The role of intermediaries in facilitating broadcast search, as well as the current status of the market for broadcast search is also presented. Chapter 3 discusses the research gaps, and the research questions that this thesis aims to answer, followed by brief summaries of the corresponding research papers. This is followed by Chapter 4 which provides a general discussion on the three research papers and concludes with the main findings of this research work. That Chapter includes theoretical contributions, managerial implications, limitations and suggestions for future research, along with the main conclusions derived from this study.

The three research papers together form Part B of this thesis. We begin with an exploratory paper based on a survey and interviews with NineSigma clients in order to understand the broadcast search process itself, the various phases of this process, and what internal actions an innovating company can take in order to improve its interactions with the intermediary and thereby increase its potential to capture value from broadcast search. That research paper I is “*Getting help from innomediaries –What can innovators do to increase value in external knowledge searches?*”

In research paper II, “*Beyond pricing decisions: business model innovation in the two sided market of an open innovation intermediary*”, we look at changes at NineSigma over the years in its pricing strategy as well as service elements in order to improve success in its two sided market by applying the two sided market model as the theoretical foundation and using a deep case study approach.

In research paper III, “*Successful and sustainable implementation of open innovation: an empirical analysis*”, we use data from a diagnostic open innovation tool from NineSigma in order to empirically create a stage-based framework of management capabilities essential for innovating companies when transitioning from closed Innovation to successful and sustainable open innovation. For that paper, we use change management theory as the theoretical framework.

The first two papers strive to further advance the understanding of success factors in broadcast search at the innovation seeking company as well as the intermediary, whereas the third paper serves to provide a guide for companies to implement open innovation successfully. The three research papers together inform different aspects of intermediated broadcast search and help to understand the organizational factors that influence success with this process. Each of the three research papers have been presented at international conferences (Table A.1).

Table A.1. Overview of research publications

	Title	Year	Submitted to/Presented at	Type
Research Paper I	Getting Help From Innomediaries – What Can Innovators Do To Increase Value In External Knowledge Searches	2014	The XXV ISPIM Conference – Innovation for Sustainable Economy & Society, June 8-11 2014. Dublin	<i>Research Conference</i>
		2014	In: Chesbrough, H.W., Vanhaverbeke, W., and West, J. (Eds.) <i>New Frontiers in Open Innovation</i> . Oxford University Press.	<i>Contribution to Edited Book</i>
Research Paper II	Beyond Pricing Decisions – Business Model Innovation In The Two Sided Market Of An Open Innovation Intermediary	2014	12th Annual Open & User Innovation Conference July 28-30 2014, Harvard Business School, Boston, MA	<i>Research Conference</i>
		2014	1st Annual World Open Innovation Conference, December 4-5, 2014, Napa, CA	<i>Research Conference</i>
Research Paper III	Successful And Sustainable Implementation Of Open Innovation: An Empirical Analysis	2015	R&D Management Conference, June 23-26, 2015, Pisa, Italy (accepted for presentation)	<i>Research Conference</i>

2. Open Innovation and Broadcast Search: Management System and Market

In this chapter, we consider key concepts and provide definitions of open innovation and broadcast search. We also discuss the structure of the open innovation marketplace. Subsequently, we describe the main stakeholders in this market: Innovation seekers, intermediaries, and solution providers. We conclude with an outlook, including some thoughts on further research questions.

2.1. Open Innovation and Broadcast Search

There is a spectrum of openness along various innovation approaches, with completely closed innovation approaches on one end and open innovation approaches on the other (Trott and Hartmann, 2009). Open innovation has been defined by Chesbrough as follows: “Open innovation is the use of purposive *inflows and outflows* of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively” (Chesbrough et al., 2006). From this definition, it follows that open innovation can be both ways – “outside-in” as well as “inside-out”. The outside-in process, or inbound open innovation, involves opening up the innovation process to knowledge exploration by means of external knowledge sourcing (Lichtenthaler, 2011). For instance, P&G’s Connect and Develop program encourages P&G researchers to reach out to external parties for innovative ideas (Chesbrough 2003). As a result, over 50 percent of P&G’s pipeline and products in the market include external technology or an external C&D connection (Huston and Sakkab, 2007). The inside-out process, or outbound open innovation, is about opening up the innovation process with the objective of commercialization of existing technological knowledge, for instance through licensing revenues and through multiplying technology by channeling ideas to the external environment (Lichtenthaler, 2011; Gassmann and Enkel, 2004). Gassmann and Enkel (2004) identify a third type of open innovation process – the coupled process – that links the outside-in and inside-out processes by working in alliances with complementary companies during which give and take are crucial for success. For instance, BMW’s car control mechanism iDrive was developed in close co-operation with different industries (Gassmann and Enkel, 2004).

This dissertation focuses on the outside-in process of open innovation, with emphasis on the method of "broadcast search", also called tournament-based crowdsourcing (Jeppeson and Lakhani, 2010).. The outside-in process of external knowledge sourcing can cover different types of knowledge sources, from integrating customers and users, external technology providers, suppliers, or academic experts (Wagner and Piller, 2012). Information sourced from these sources can either refer to need information (customer needs, preferences) or solution information (technical information). There are many methods for outside-in open innovation, including the lead-user method, toolkits, innovation or idea competitions, broadcast search platforms and open innovation communities. Customers are best integrated via lead-user method, toolkits, idea competitions and online communities; external experts are best integrated using the broadcast search methodology (Wagner and Piller 2012).

Broadcast search is an approach for technical problem solving that focuses on broadcasting problems to diverse and peripheral problem solvers (Lakhani 2006). It is a radical departure from traditional problem solving – it requires minimal engagement of the problem holder in actual problem-solving, but instead involves generating interest among a heterogeneous set of external actors in creating solutions to internal problems (Lakhani 2006). Jeppeson and Lakhani (2010), by means of an empirical analysis on a large number of scientists, revealed an important feature of broadcast search – the probability of a problem being solved is significantly correlated with the heterogeneity in the scientific interests of the solvers submitting solutions and their relative specialization. In other words, the increasing distance between the solver's field of technical expertise and the focal field of the problem is positively related to the probability of arriving at a winning solution.

Broadcast searches are often facilitated by intermediaries – specialized firms that provide professional knowledge search expertise to companies seeking knowledge or innovations (Luettgens et al. 2012). These intermediaries (or "innomediaries") operate as a platform provider that enables interaction between two networks that value each other's presence – the Innovation Seekers and the Solution Providers. Figure A.2 illustrates the process flow of broadcast search via intermediaries.

Intermediaries provide their services in the form of "packaged" innovation search services. They do this by applying pertinent technological infrastructure on one hand, while accessing a community of Solution Providers – scientists and experts from industry, academia, and research institutes from around the world (Roijsackers et al., 2014) to provide solutions to companies seeking innovations.

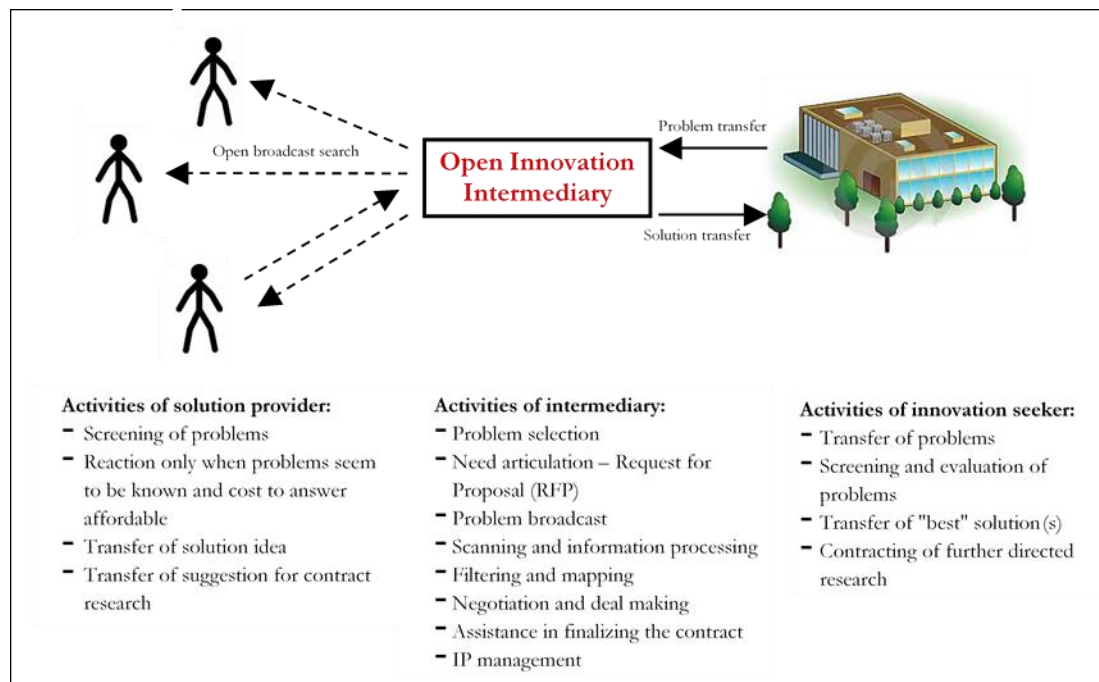


Figure A.2. Open innovation process flow (adapted from Piller, 2010).

As I will discuss in more detail in Paper I of my thesis, the services of an intermediary span multiple areas of the innovation value chain. The intermediary facilitates the entire process of broadcast search that ranges from need articulation, to problem broadcast, filtering and mapping of solutions, to final negotiations, deal making, and IP management (Rojjakkers et al., 2014). The process flow of innovation search services provided by intermediaries in an intermediated

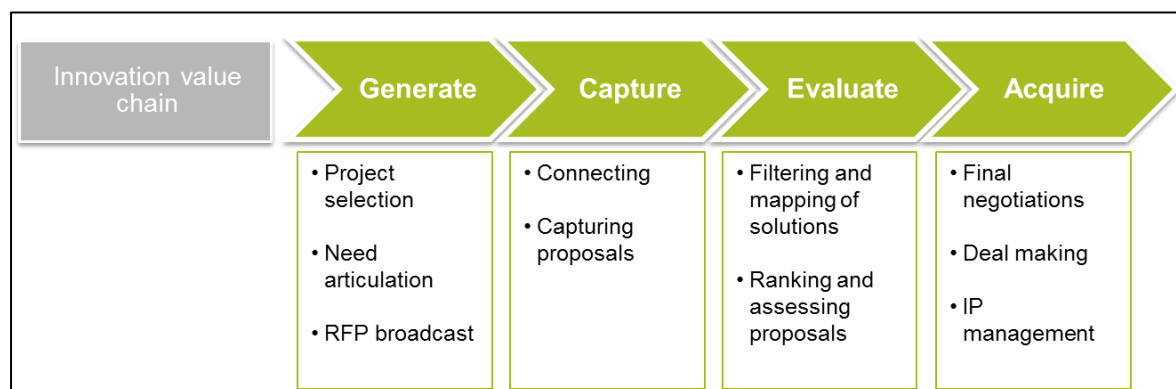


Figure A.3. Blueprint of the broadcast search method of open innovation via intermediaries (adapted from Hansen and Birkinshaw, 2007)

broadcast search process resembles an integrated process flow for the innovation value chain (Hansen and Birkinshaw, 2007). It requires for companies that want to use this method successfully to build internal capabilities (processes and routines). Thus, intermediated broadcast search is more than just an open innovation tool, it clearly has become an innovation management

system. Figure A.3 presents a blueprint of the intermediated broadcast search method as a management system.

Success in broadcast search has many possible dimensions. One way of defining success may be the signing of a contract for transfer of intellectual property between a solution provider and an innovation seeker as a result of a solution submitted. This is one of the dimensions of “Search Success” (Roijakkers et al., 2014). Then there is the economic / financial success of the innovation seeker (“Seeker Success”), the financial / economic success of the solution provider that submits solutions as a result of broadcast searches (“Provider Success”), as well as the financial / economic success of the intermediary itself (“Intermediary Success”). Finally, success in open innovation can be measured in terms of the products resulting from open innovation programs that have been commercialized and are in market, like P&G’s Swiffer Dusters®, General Mills’ Progresso Light® Soups, etc.

For the open innovation market to grow and be sustainable, it is imperative to identify the success factors – both within the company as well as at the intermediary – that influence the outcome of an open innovation program.

My research work attempts to do just this by systematically identifying:

1. Internal actions that can be taken by companies to improve success with intermediated broadcast search;
2. Service elements at the intermediary that positively influence success rates with broadcast search;
3. Specific capabilities that companies need to build, stage-wise, in order to instill open innovation into its innovation culture and thus successfully implement open innovation.

The three research papers, introduced in more detail following this, address each of the above points, respectively.

2.2. Stakeholders in an Open Innovation System

The demand for services of open innovation intermediaries has grown across different industry sectors in recent years (Diener and Piller, 2013). A McKinsey Global Survey finds that following the economic downturn in 2009, a significant number of companies have sharpened their focus on collaborating with outside R&D groups and increasing the use of global R&D resources in an

effort to raise discipline and reduce R&D costs within their organization (Barrett et al., 2010). The market size for intermediated open innovation services was estimated to be Euros 2.7 billion in 2013, and is expected to double by the end of 2015 to Euros 5.5 billion. The open innovation market, as of 2012, has been dominated by the broadcast search method that accounts for almost 80% of the market (Diener and Piller, 2013).

The main stakeholders of the open innovation market are the innovation seeker with a technical need; the intermediary helping the seeker to source innovations; and innovation communities of the intermediary that represent the potential solution providers.

The innovation seeker: This is any organization seeking an innovation response either in the form of suggestions for product improvements, or in the form of solutions to a specific technical problem (Diener and Piller 2013). When companies engage with intermediaries in broadcast search, they typically go through four phases: orientation, exploration, selection and engagement. The Orientation phase involves working closely with the intermediary to formulate the need clearly and translate it into a “Request for Proposal” (RFP). The Exploration phase involves exploring interesting solution proposals received as a result of the broadcast search. The selection phase involves deciding which solution provider(s) (if any) to engage with. The Engagement phase involves the process of actual deal-making, facilitated by the intermediary (Figure A.4).

The intermediary: Intermediaries specialize in the articulation, identification, and selection of new technology options; in scanning and locating of sources of knowledge; in building linkages between external knowledge providers; and in developing and implementing business and innovation strategies (Bessant and Rush, 1995). Thus the primary goal of intermediaries is to help their clients with their external knowledge sourcing. There are two major kinds of Intermediaries in the open innovation marketplace that each operate on different business models: one model involves running open innovation projects on behalf of clients and providing solutions to specific needs; and the other one whereby they help clients build their own open innovation competencies by means of software packages in order to engage in direct collaboration with external entities (Diener and Piller 2010). The types of services offered by intermediaries may fall into one or more of the following categories: 1. Open innovation workshops; 2. Broadcast search; 3. Search for market (need) information; and 4. Search for technical (solution) information, with broadcast search being by far the most frequent service offered by intermediaries (Diener and Piller 2013).

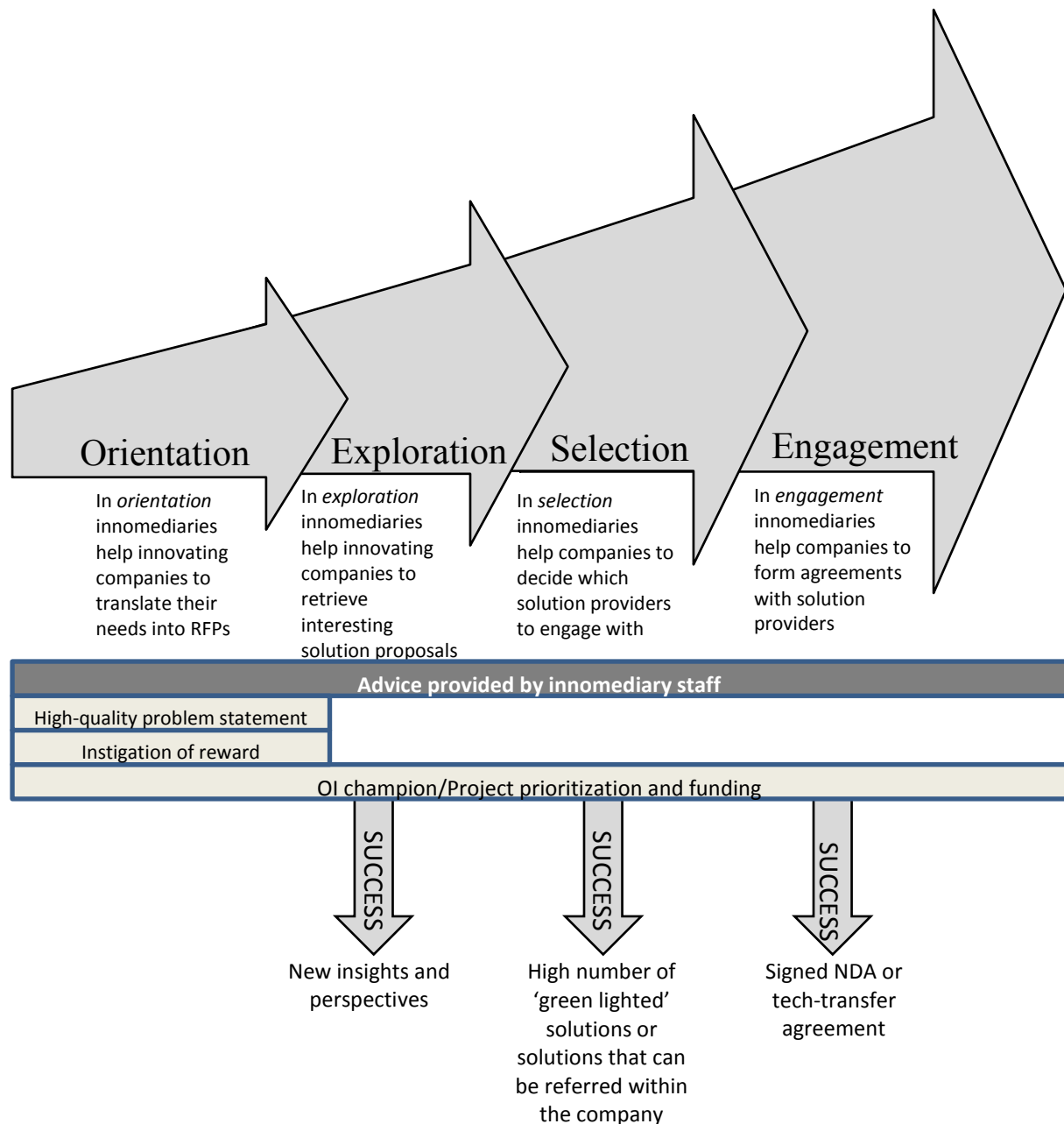


Figure A.4. Four phases of the intermediated broadcast search process, value added by intermediaries at each phase, and key success factors related to each phase.

Intermediaries serve as a platform that connects innovation seekers and solution providers. They thus operate under a two-sided market model (Rochet and Tirole, 2003). Two-sided intermediary markets are driven by “indirect network effects”: the probability of arriving at a worthwhile technical solution for the innovation seeker increases with the number (and quality) of solution providers that respond to the call for solution proposal (Kouris and Kleer, 2012). Hence, it is important for the intermediary to build a robust network on both sides of the market and win over both sides of the market to stay in business (Kouris and Kleer, 2012). The role of the intermediary is thus more than that of a mere “technology broker”. Open Innovation service

intermediaries are professional bodies that make significant contributions to the overall success of the open innovation process by continuously reflecting upon their own internal processes, and improving them by means of customer feedback, and extant competitive and market pressures. Several research studies acknowledge the role played by the intermediary in developing, accelerating, and controlling the knowledge and dynamic competences necessary to solve complex innovation problems, and in fostering the diverse linkages between various geographically dispersed entities or innovation networks (Howells, 2006; Boudreau and Lakhani, 2009; Luettgens et al., 2012).

The solution provider: These are external parties (e.g. engineers/scientists/inventors) that provide ideas and technology solutions, often new or unknown to the innovation seeker. The composition and quantity of solution provider communities varies greatly among intermediaries. Services like technical searches involve individuals for example with expertise in applied and natural sciences. Community members for design contests or market searches are characterized by experience in the fields of arts or social sciences. On average, intermediaries have a community of about 20,000 members (Diener and Piller 2013). For some intermediaries, this number may be substantially higher, especially for those that specialize in broadcast search. For example, NineSigma maintains an innovation community of more than 2 million solution providers. Innovation communities are generally internet based and supported by specialized software. Software technologies form an essential part of any open innovation venture.

3. Research Questions and Research Papers

Over the last decade, a global "open innovation marketplace" with numerous intermediaries has emerged that is helping companies to gain access to external technologies and expertise (Bingham and Spradlin, 2011). The intermediaries have evolved their services and business models as a result of growing competition and market pressures (Sawhney et al. 2003). At the same time, innovation seekers have begun to organize themselves better in order to make more effective use of intermediated services in their external knowledge searches (Salge et al., 2012; Laursen and Salter 2014). These developments have led to "indirect network effects", with increased participation of the members of solution provider communities resulting in an improvement in the quality and quantity of solution proposals received by intermediaries (Kouris and Kleer, 2012). I believe that these advances in the open innovation marketplace call for research which would help to analyze and better understand the organizational factors that influence success in open innovation. The research questions guiding my thesis are outlined and the corresponding research papers of Part B of this thesis are summarized below.

3.1. Overview

My thesis examines organizational success factors at the innovating company and the intermediary for long-term success with open innovation, using the example of intermediated broadcast search. As I aimed to perform this analysis from different viewpoints and through different research questions that involved different theoretical foundations and available data sets, a single research methodology across all research papers would not have been adequate. That is why this thesis and the corresponding research papers encompass a mixed-method research approach (Johnson & Onwuegbuzie, 2004) in which qualitative and quantitative analyses are combined to derive results. This thesis combines literature reviews, qualitative assessments and quantitative data, and is thus based on a wide set of sources most suitable for the different points of view. The primary goal of combining different methods was of complementary nature in order to "[...] measure overlapping but also different facets of a phenomenon, yielding an enriched, elaborated understanding of that phenomenon" (Greene et al., 1989, p. 258). The mixed-method approach is applied to answer different research questions. In this way, my thesis is motivated by some overarching research questions which are further supplemented by specific sub-questions that guide the content of each research paper.

The following overarching research questions are the focus of this thesis:

- A. What do innovating firms using intermediaries do in order to improve their success with broadcast search?
- B. How does business model (process) innovation at intermediaries drive success for the different sides of the two sided market model of an intermediary?
- C. Which management capabilities and in what sequence do companies build for successful and sustainable implementation of open innovation?

In order to answer these research questions I started with the research paper “*Getting help from innomediaries – What can innovators do to increase value in external knowledge searches?*” in which I looked at the interactions between innovating companies and intermediaries. This exploratory research is comprised of an online survey administered to 260 innovating companies working with NineSigma, and a set of 21 interviews conducted with NineSigma clients.

In particular, the following specific research questions were investigated in Research Paper I:

- How can innovating companies derive more value from broadcast search when working with an intermediary?
- What specific capabilities and activities do companies show in the different phases of broadcast search when using intermediaries?
- How do companies using intermediaries define success with broadcast search?

I then focused on the intermediary itself in my second research paper “*Beyond Pricing Decisions – Business Model Innovation in the Two Sided Market of an OI Intermediary*” in order to identify the business model and process changes at the intermediary over time that have led to increased success from broadcast search. To date, intermediaries are looked at as a black box and a static element, and with this paper I open that black box. I applied the theory of two sided markets, and specifically showed that an intermediary’s two-sided business model goes beyond pricing as the only success variable as mentioned in literature (eg, Eisenmann 2006), by introducing service quality as another factor of at least equal importance.

For this research paper II I used a mixed qualitative and quantitative approach. I interviewed NineSigma’s service staff to determine changes to NineSigma’s original service archetype over time, and reviewed data for clients that have performed more than 50 broadcast searches with

NineSigma over at least 3 years in a row in order to understand the impact of this change on the clients.

The following specific research questions were investigated in Research Paper II:

- How is success in broadcast search defined across all market sides?
- How do business model and process changes at an intermediary that operates in a two sided market impact the success of different market sides?”

In my third research paper “*Successful and Sustainable Implementation of Open Innovation: An Empirical Analysis*” I examined the process of implementation of open innovation, specifically broadcast search, within the framework of an organizational change management process. Under this framework, the implementation process is seen as going through three phases, from “closed innovation” to “early-stage open innovation” to “intensive use of open innovation”. At each of these phases, companies build certain management capabilities that aid them in practicing open innovation. With the help of a multinomial logistical regression analysis of responses to an online survey from 756 organizations performed by NineSigma, this paper identifies the management capabilities that companies build step-wise during their implementation of open innovation.

The following specific research questions were investigated in Research Paper III:

- Which management capabilities are important for successfully implementing open innovation as a management system?
- In what sequence do companies build those management capabilities in order to successfully implement open innovation as a management system?

Having outlined the overarching research questions of my thesis and each research paper’s specific research questions, I summarize the main results of the three research papers in the next section.

3.2. Summaries of Research Papers

This section provides short summaries of the three research papers constituting the main part of this thesis. I summarize the research papers by first providing a brief motivation, followed by the theoretical background and research highlights of each paper. Table A.2 compiles the short summaries which are set out below.

Table A.2. Overview of research papers.

Research Paper I: Getting Help from intermediaries – What can innovators do to increase value in external knowledge searches	
<p>Central research question: What can innovating companies do to increase value when they engage with intermediaries in external knowledge searches and thus increase the likelihood of signing beneficial agreements with solution providers?</p>	<p>Research methodology:</p> <ul style="list-style-type: none"> • Structured literature review • Online survey • Interviews
<p>Key findings: On the basis of interviews and survey research, identifies the internal actions innovating companies can themselves take to increase value from interacting with intermediaries in all phases of their external knowledge searching.</p>	
Research Paper II: Beyond pricing decisions – business model innovation in the two sided market of an open innovation intermediary	
<p>Central research question: How do business model and process changes at an open innovation intermediary that operates in a two sided market impact the success of different market sides?</p>	<p>Research methodology:</p> <ul style="list-style-type: none"> • Structured literature review • Qualitative research design • Case study research • Interviews • Database analysis
<p>Key findings: Highlights by means of a case study on NineSigma that intermediaries are not static elements in the open innovation marketplace, but are continuously evolving their business model as well as service processes in response to market pressures. Adopts the two-sided market model to study the internal functioning of an intermediary. Illustrates empirically the positive impact of pricing and service archetype changes on success at all three stakeholders: innovation seeker, solution provider, and the intermediary itself.</p>	
Research Paper III: Successful and sustainable implementation of open innovation: an empirical analysis	
<p>Central research question: Which capabilities do companies build and at which stage of their change management process in order to successfully implement open innovation as a management system?</p>	<p>Research methodology:</p> <ul style="list-style-type: none"> • Structured literature review • Online survey • Multinomial regression analysis
<p>Key findings: Adopts the organizational change management framework to study the implementation of open innovation. Empirically illustrates that companies build management capabilities in a step-wise manner when implementing open innovation. Identifies which management capability is built at what stage of the implementation process.</p>	

3.2.1. Research Paper I: “Getting Help from Innomediarities – What Can Innovators Do To Increase Value in External Knowledge Searches”

Over the past decade the importance of intermediated open innovation services has increased for both academia and practitioners, as evidenced by the growing body of literature on this topic. Some of these publications have been descriptive in nature highlighting important trends in the intermediated open innovation service industry and describing its main characteristics (Arora et al., 2001; Enkel et al., 2009). Other studies have focused on the value innovating companies can potentially derive from using intermediated services and have identified the factors (usually outside the firms’ sphere of influence) that affect the potential value accruing to innovating companies when interacting with innomediarities/solution providers (Dushnitsky and Klueter, 2011; Lichtenthaler and Ernst, 2008) and the motivations behind solution providers’ involvement in markets for solutions (Boudreau and Lakhani, 2009; Che and Gale, 2003). Despite this growing body of literature on intermediated services relatively little attention has been paid so far to what innovating companies themselves can do to increase the value they derive from working with innomediarities throughout all phases of external knowledge searches. Some companies are more successful at deriving value from their interactions with innomediarities than others. These differences can partly be linked to the actions innovators take internally to add to their value capturing potential. The objective of Research Paper I was to identify these internal actions and thus help innovating companies to increase the value they generate when using intermediated open innovation services, specifically broadcast searches.

Through exploratory research we first identified the four phases through which innovating companies go when they engage in external knowledge searches whilst seeking the help of innomediarities. These are: orientation, exploration, selection, and engagement. For these phases of external knowledge searching we identified a set of actions that innovating companies can take to increase the likelihood of successfully engaging with innomediarities and solution providers. We found that during the orientation phase, when innovating companies join forces with innomediarities to formulate their technological needs and translate these needs into Requests for Proposals (RFPs), more effectively teaming up with an innomediarities and jointly developing an RFP that defines a high-quality problem statement is the first step toward a successful broadcast search. Another important action that innovating companies can take to be more effective in their interactions with innomediarities is to instigate a reward for successful solutions in the orientation phase. Likewise, to stimulate more effective interactions with innomediarities throughout all phases of external knowledge searching innovating companies need to appoint an OI champion to support the project as well as label the project as ‘strategic’ and fund it as such.

Thus, I summarize the following research highlights of Research Paper I:

- Identifies the four phases of external knowledge searches whilst seeking the help of innomediaries
- On the basis of interviews and survey research, identifies the internal actions innovating companies can themselves take to increase value from interacting with innomediaries in all phases of their external knowledge searching.
- Identifies the main avenues for future research on intermediated broadcast search

3.2.2. Research Paper II: “Beyond Pricing Decisions – Business Model Innovation in the Two Sided Market of an OI Intermediary”

It has been widely acknowledged that innovation intermediaries play an important role in developing, accelerating, and controlling the knowledge and dynamic competences necessary to solve complex innovation problems, and in fostering the diverse linkages between various geographically dispersed entities or innovation networks (Howells, 2006; Boudreau and Lakhani, 2009; Luettgens et al., 2012; Roijakkers et al., 2014). The role of the intermediary is thus more than that of a mere technology broker. Literature on internal functioning of open innovation intermediaries has so far been limited to discussing aspects such as the different roles and functions of the intermediaries (Howells, 2006); ways to bring in external knowledge by harnessing the power of intermediary networks (Billington and Davidson, 2012); or the role of intermediaries as architects in the form of co-creators and enablers of collective knowledge creation (Agogue et al., 2013). Little attention has been paid so far to the various aspects and systemic evolution of the functioning of the intermediary itself over time, and how such changes have influenced success. Research Paper II focused on the two-sided business model of NineSigma, and specifically their technology search process that is typically done in the form of an open broadcast search (Jeppesen and Lakhani, 2010).

The paper showed that intermediaries operating in two-sided markets continuously evolve their business model as a result of market pressures. This evolution is not only evident in the pricing model, as is generally seen in two-sided markets, but is also clearly present with respect to service quality adjustments. By reviewing the internal service archetype at NineSigma, we identified two service process changes that ultimately resulted in increased rates of success from the viewpoint of all three stakeholders: the innovating company, intermediary, and solution provider. The introduction of a rigorous project selection step in the client engagement process

led to fewer projects overall, but more fully funded RFPs and higher rates of deal closure. This in turn increased interest among solution providers in submitting solution proposals, and NineSigma ultimately benefitted from this development by way of better credibility with clients, higher client satisfaction and repeat clients. The introduction of Solution Provider Evaluation Support – a comprehensive “back end” process that helps clients prioritize the received solutions and facilitates interaction between the client and the solution provider – led to a faster, more systematic process, that served to increase satisfaction among clients as well as service providers, and increased deal closure rates.

Thus, I summarize the following research highlights of Research Paper II:

- Points out that current literature on intermediated open innovation assumes the intermediary to be a static element in broadcast searches over time
- Shows that the intermediary is continuously evolving and is an important contributor to overall success from broadcast search
- Identifies the business model and process changes at NineSigma over the last few years, driven by market and competitive pressures
- Illustrates by means of quantitative and qualitative data the positive impact of these changes on the overall success resulting from broadcast search

3.2.3. Research Paper III: “Successful and Sustainable Implementation of Open Innovation: An Empirical Analysis”

Open Innovation is a management method that requires a deep organizational change within the innovating firm (Chiaroni et al., 2011). The majority of open innovation literature focuses on *obtaining* innovations from external sources (West and Bogers 2013). The process at the back-end, namely the ultimate *implementation* of the approach as a management method for the acquisition of external technological knowledge has hardly been researched. What’s more, those few studies on the back-end part have been in the context of case studies involving a single or only a few companies (Huston and Sakkab, 2006; Haour, 2004; Kirschbaum, 2005; Chiaroni et al., 2010; Chiaroni et al., 2011; Luettgens et al. 2012). Thus, a holistic framework based on empirical analysis of a large number of companies, across industries and regional boundaries is clearly lacking. Research Paper III fills this gap by examining the process of implementation of open innovation.

This paper adopted the framework of organizational change management process and defined a company implementing open innovation as going through three phases, from “closed innovation” to “early-stage open innovation” to “intensive use of open innovation”. By analyzing the responses to an online survey, this paper identified the management capabilities that companies build when transitioning from closed innovation to early-stage, and then further to intensive use. It emerged that companies take the “path of least resistance” when implementing open innovation as an organizational change. They typically start with using the services of intermediaries and tech scouts to access global knowledge. Only after the organization has had experience with these initial projects, it moves on to further refining the open innovation process by building other essential capabilities such as internal processes to encourage knowledge creation, sharing and utilization within and outside firm boundaries, and thereby increasing its absorptive capacity (Salge et al. 2012; Lewin et al., 2011); broadening and efficiently managing its external networks comprised of known entities external to the organization (Laursen and Salter 2006), further increasing its access to global knowledge by joining consortia and other collaborative activities (Perkmann 2009), and building capabilities directed toward efficiently leveraging external knowledge and integrating it into the internal R&D activities (West and Boger 2013). This empirical analysis, based on real-world practices, covered a large number of companies across different industries, regions and sizes, and may prove to be an effective guide for organizations wanting to introduce and implement the broadcast search method of open innovation.

Thus, I summarize the following research highlights of Research Paper III:

- Shows that implementing open innovation needs to be considered as a change management problem
- Identifies the management capabilities essential in implementing open innovation
- Empirically identifies which management capability is built by companies at what stage of implementing open innovation
- States clear practical implications on how to implement open innovation successfully and sustainably

4. Discussion and Conclusions

In this chapter I discuss important implications of my research for both theory and practice. This chapter is structured as follows: Section 4.1 summarizes the theoretical contributions provided by the research papers in Part B of this thesis. Section 4.2 highlights the managerial implications of the papers' findings, followed by the limitations of this work and some thoughts on future research in Section 4.3. The key conclusions from this research work are drawn in Section 4.4, thereby closing Part B of my thesis.

4.1. Theoretical Contributions

The research papers presented in Part B of this thesis seek to extend previous knowledge organizational success factors in the broadcast search method of open innovation facilitated by intermediaries.

Considering the research gaps pointed out in Chapter 3, each paper addresses one or more corresponding research questions from the above perspective. At the same time, a respective literature analysis also provides the relevant theoretical perspectives which contextualize the research framework.

There have been research studies analyzing various aspects of intermediated broadcast search that substantiate the value of the broadcast search method itself (Lakhani et al., 2006; Jeppeson and Lakhani, 2010), outline the organizational procedures and practices that help in implementing broadcast search (Luettgens et al., 2012; Luettgens et al., 2014), and identify ways to facilitate increased responses from solution providers (Che and Gale, 2003; Boudreau and Lakhani, 2009; Antikainen, 2011). However, there has been no study that analyses the factors that influence success in broadcast search from the viewpoint of the innovating company as well as the intermediary. Especially with regard to the context of the intermediary, studies have been limited to discussing aspects such as the different roles and functions of the intermediaries (Howells, 2006); ways to bring in external knowledge by harnessing the power of intermediary networks (Billington and Davidson, 2012); or the role of intermediaries as architects in the form of co-creators and enablers of collective knowledge creation (Agogue et al., 2013). There has been a research gap in identifying the potential of the intermediary to act as a variable whose functioning can affect the overall success from broadcast search. Furthermore, there is a clear gap

in literature in identifying the capabilities, resources and actions required at an innovating company and the sequence in which these capabilities can be built in order to implement open innovation successfully and for a long term. With this research work I attempt to close these gaps, thereby giving academia and practitioners the framework to better apply open innovation, more specifically, broadcast search. The thesis thereby fosters progress of research in this field, which lacks empirical insights.

Research Paper I initiates this interesting avenue of research by providing close observations of the practical processes followed when innovating companies engage in broadcast search whilst seeking the help of intermediaries. This addresses the research question “*What can innovating companies do to increase value when they engage with intermediaries in external knowledge searches and thus increase the likelihood of signing beneficial agreements with solution providers?*” In doing so, this paper identifies the variables that lead some companies to be more successful at deriving value from their interactions with intermediaries than others. It thus turns out that the difference in success rates from intermediated broadcast search is partly linked to the actions innovators take internally to add to their value capturing potential. While some authors (Ceccagnoli et al, 2010) have identified a number of factors influencing the potential value innovating companies can derive from using intermediated open innovation services these factors are mostly difficult to change or beyond the direct sphere of influence of most companies. This paper hence focuses on what innovating companies *can do* internally i.e. a specific set of actions that innovating companies can take at the very beginning of their external knowledge searching, to increase the likelihood of success when engaging with intermediaries. The paper builds on a few other studies (Boudreau and Lakhani, 2009; Lakhani and Jeppesen, 2007; Lichtenthaler and Ernst, 2008; Ihl et al, 2012), thereby joining existing theoretical perspectives and the empirical findings from this work. The findings of this paper expand the understanding of organizational success factors at the intersection of innovation seeker and intermediary very specifically by deriving a set of actions that have proven to increase success with intermediated broadcast search across different industries. They form a basis for further research that may validate and expand on the results.

Research Paper II applies a deep case study approach in order to identify business model and process changes at the intermediary that can influence success with broadcast search. This addresses the research question “*How do business model and service process changes of an open innovation intermediary that operates in a two sided market impact the success of different market sides?*” The paper introduces the intermediary as a platform provider that enables interaction between two networks that value each other’s presence – the innovation seekers and

the solution providers. Intermediaries thus operate on the model of two sided markets. By basing the paper on the two-sided market theory, and using the business model of NineSigma as a case study, this paper sheds light on the process changes and service innovations that have occurred at NineSigma over the past few years, and how these changes have impacted both sides of the intermediary market, as well as the intermediary itself. These changes together form the variables of success at the intermediary, thereby establishing the intermediary as a dynamic element, unlike most studies on success with open innovation that consider the intermediary as a static element and a black box. More specifically, current two sided market theory sees pricing as the only variable that determines success in two sided markets (eg Eisenmann et al., 2006). The paper clearly shows that service (and thus process) changes have an influence of at least equal importance, thereby expanding current two sided market theory. It also provides a starting point for further research.

Research Paper III sheds light on the research question “*Which capabilities do companies build and at which stage of their change management process in order to successfully implement open innovation as a management system?*” Correspondingly, it advances knowledge on implementation of open innovation by providing a process sequence in which innovating companies build management capabilities that aid them in practicing open innovation successfully. Until now, most research has focused on identifying the management capabilities that are essential in implementing open innovation (Alexy et al. 2013; Foss et al. 2011; Laursen and Salter 2014; Salge et al., 2012). These studies have relied either on theoretical or on case study based empirical approaches wherein the implementation process of one or a few companies are analyzed and results derived. This paper considers open innovation as a management system and applies the organizational change management theory to the implementation process in order to empirically answer the research question as above. The study, based on an online survey of 756 organizations, uses samples from across different industries and locations, and thus is industry- and location-agnostic. This paper provides a comprehensive empirical analysis across different industries of geographies on the building of management capabilities for the adoption of open innovation as a management method. It contributes to scientific literature the understanding of the specific capabilities built, and the sequence in which said capabilities are built during the process of going from no innovation to intensive and successful use of open innovation over time.

My thesis combines different research tools to define a set of variables that prepare the ground for organizations to achieve higher success rates in open innovation, specifically the intermediary-facilitated broadcast search method. In summary and bearing in mind the importance of this new management system for the industry, the results from this study expand

the theory of two sided markets, as well as the theory of change management in the adoption of open innovation as a management system.

4.2. Managerial Implications

My thesis is a compilation of a set of information extracted from NineSigma's databases and a host of interviews and case studies of practitioners of open innovation. Thus, my thesis is rich in real-world data, analyzed on the basis of robust theoretical foundations. As a result, the thesis provides a collection of facts that can support a manager in taking informed decisions regarding open innovation.

In particular, open innovation has been shown to be a management method that can be best implemented as an organizational change management process. In research paper I, on the basis of interviews and survey research among NineSigma clients, I highlight several actions innovating companies can themselves take to increase value from interacting with intermediaries in all phases of their broadcast search. More and more innovating companies with broad technology portfolios in automotive, pharmaceuticals and medical devices, communications and defense, and other sectors of industry make use of intermediated broadcast search services to stimulate their external knowledge searches. While these typically large companies (early adopters such as Siemens, Glaxo-SmithKline, and Jaguar Land Rover) have gained substantial experience in open innovation and the use of sophisticated open innovation tools, intermediaries have broadened their service offerings in the initial phases of external knowledge searching and expanded their activities to also cover intermediated services in the final phases of external searches and open innovation consultancy in all phases. This exploratory research identified several routes to improving the chances of success when engaging in broadcast search: Optimizing the RFP writing process; rewarding solution providers that add value to internal problem-solving; appointing an experienced, high-profile open innovation champion to stimulate external knowledge searches; prioritizing open innovation projects and allocating long-term funding to these initiatives. What is interesting about these results is that there is a specific set of actions that innovating companies can take at the very beginning of their external knowledge searches, that is before even putting out an RFP (defining a high-quality problem statement and including an attractive reward for valuable solutions to the RFP). This significantly increases the likelihood of engaging with solution providers in the final stage of external knowledge searching.

Research paper II, by means of quantitative and qualitative evidence, shows that organizational changes happen at the intermediary as well, and that the intermediary organizations, under extant market pressures, strive to improve their interactions with the innovating company as well as solution providers. Market pressures lead to the need for intermediaries to continuously evolve their business model with respect to pricing. Specifically, for NineSigma, in the beginning stages of market development, relatively low project prices on the seeker side only along with a transaction fee in case of deal closure (i.e. a success fee) was sufficient to build both sides of the market. However, as the market matured and pressures were building both from the side of the early adopter customer base, as well as the competition, raising the project fee in favor of dropping the transaction fee altogether led to more growth and client satisfaction. This largely confirms existing literature on two-sided markets. This is a surprising result as the expectation would have been for market based approaches to prevail over fixed fee models. In other words, an entrepreneurial stance of buyers would be to go for lower fixed fees and higher variable ones with a view to sharing in successful outcomes. Anecdotal evidence from practice at NineSigma points to the fact that buyers at large corporate organizations – the primary client base of NineSigma – are more concerned with predictable budget allocations for projects vs the variable “shared risk / shared reward” approach. The incremental benefit of fixed cost pricing seems to outweigh the incremental benefit of potentially lower and pertinent variable project fees.

Market pressures also led to the need to change the service process archetype, which had an impact both on the economic success of NineSigma, as well as the client network and the solution provider network through improved deal closure rates and client satisfaction. Improved service quality had an indirect network effect as well. When NineSigma changed its service archetype to include more care for and many more touch points with solution providers it led to more proposals being submitted by solution providers. Increasing amounts of proposals in turn led to clients wishing an adjustment of the service process archetype in order to be able to absorb all of the proposals, which also led to accelerated evaluation processes and thus higher deal rates.

Research paper III lays out a sequence in which companies can build management capabilities essential for implementing open innovation. The paper shows that it is not imperative that companies build all capabilities – many of which require intensive organizational changes involving a multitude of stakeholders – right at the start of introducing and implementing open innovation. The findings suggest that companies take the “path of least resistance” when implementing open innovation as an organizational change. Companies typically start with using the services of intermediaries and tech scouts to access global knowledge. Out of all management capabilities considered in this study, accessing global networks through intermediaries and tech

scouts require the least amount of change efforts, and hence companies tend to begin their open innovation journey through these sub categories. This finding confirms pertinent management literature that suggests that any organizational change process will encounter significant resistance from the people most affected by the change (Kotter 1995; Judson, 1991). Change management literature also suggests that in order to maintain the momentum of a change effort, it is imperative to assign short-term goals and achieve short-term wins (Kotter 1995). Approaching an intermediary or appointing a tech scout for a few initial open innovation projects offers the opportunity for the organization to gain experience and test the impact of the change. Only after the organization has had experience with these initial projects, it moves on to further refining the open innovation process by building additional capabilities such as internal processes to encourage knowledge creation, sharing and utilization within and outside firm boundaries, and thereby increasing its absorptive capacity (Salge et al. 2012; Lewin et al., 2011); broadening and efficiently managing its external networks comprised of known entities external to the organization (Laursen and Salter 2006), further increasing its access to global knowledge by joining consortia and other collaborative activities (Perkmann 2009), and building capabilities directed toward efficiently leveraging external knowledge and integrating it into the internal R&D activities (West and Bogers 2013). In particular, the fact that companies build internal processes and structures supporting open innovation at a later stage and do not build them early on was a surprising finding. The presence of internal processes such as incentive systems and cross-functional collaborations within the organization positively influence the returns from open innovation (Dahlander and Gann, 2010; Salge et al., 2012). Even in my experience as the CEO of NineSigma, there have been a lot of clients who said they need to get their internal structures and processes in order first before engaging in open innovation. The contrary finding might stem from the fact that building internal processes is not a simple task, but requires a significant change within the organization. It is well known from change management literature that organizational change efforts tend to face resistance and it does take considerable amount of time to successfully implement a change (Judson, 1991). Kotter (1995) aptly quotes “most people won’t go on the long march unless they see compelling evidence in 12 to 24 months that the journey is producing expected results”. For this reason, companies might start out with building “easier” and less incisive capabilities.

Lastly, it is worth noting that “success” with open innovation can have many dimensions. In research paper I we identify success from the perspective of NineSigma’s clients in relation to the help they receive from NineSigma at each phase of broadcast search. For example, the exploration phase is considered to be successful by NineSigma clients when they are able to gain access to new insights and perspectives with respect to their internal problem-solving initiatives.

In the selection phase NineSigma clients perceive a high number of ‘green lighted’ solutions and the number of solution proposals that can be referred to other departments within the client organization as a successful outcome. Innovating companies also perceive the engagement phase to be successful when they sign a beneficial NDA or a tech-transfer agreement with a solution provider. In research paper II success is defined from the perspectives of the various sides of the intermediary’s two-sided market. There is the economic / financial success of the intermediary itself (“Intermediary Success”), the financial / economic success of the Innovation Seeker side (“Seeker Success”), and the financial / economic success of the Solution Provider that submits solutions as a result of Broadcast Searches (“Provider Success”). Additionally, literature provides some general definitions of a successful outcome from broadcast search – lowered internal R&D costs, reduced R&D risks, shorter time-to-market, and access to new ideas (Arora et al, 2001; Enkel et al, 2009; Lichtenthaler and Ernst, 2008). Finally, success in open innovation can be measured in terms of the products resulting from open innovation programs that have been commercialized in market, like P&G’s Swiffer Dusters®, General Mills’ Progresso Light® Soups, etc. Thus, success in broadcast search is multi-tiered, and one needs to be very specific about what constitutes a successful outcome when analyzing the results from broadcast search.

4.3. Limitations and Future Research

The research results presented in this thesis have certain limitations that I highlight in this section. Even though each research paper comprehensively points out its specific issues, the following discussion highlights central limitations of the overall results of the thesis.

My thesis examines the organizational success factors for open innovation using the example of broadcast search via intermediaries. As such, my thesis considers the experience of only one open innovation intermediary – NineSigma. For this reason, there are some limitations to the conclusions that can be drawn from this study. Experiences with other intermediaries may be different, and hence the findings of this study cannot be easily generalized with other empirical settings. The perspective of the innovating company is also based on interviews and surveys with NineSigma’s clients. A more extensive analysis of a broader pool of innovating companies outside NineSigma’s client base, and direct interviews with their representatives, could have revealed more factors that may have had an influence on the overall success of the broadcast search process. Furthermore, in the present study my focus has been on one form of open innovation only – broadcast search. Perhaps a good subject for future research could be to

investigate whether the observations from this study can be transferred to other forms of open innovation such as technology landscaping or ideation contests.

The limitations mentioned above apply to all the three research papers of this thesis. In addition, research paper III, while analyzing the capabilities and expertise currently existing in the respective organizations that promote and support the implementation of open innovation, does not analyze whether the organizations used in the sample data are successful in implementing open innovation or not. However, there are several case studies that illustrate the positive influence of each of the management skills and capabilities outlined in this study on the implementation of open innovation (Buganza et al. 2011; Huston and Sakkab 2006; Dittrich and Duyster 2007). As a result, this paper assumes that organizations in the sample data that successfully constructed management processes, skills and capabilities to promote open innovation are successful in implementing open innovation. Future studies in this area should look at other success factors of responding organizations, like additional revenue through open innovation etc. in order to determine that the companies are indeed successfully using open innovation. Another limitation of research paper III is that it has a “single information bias” and is a subjective assessment of the respondents. Further refinement of this study can be achieved by triangulating the findings using qualitative data through interviews with managers from organizations practicing open innovation.

Beyond these limitations, there are several possible avenues for future research targeted towards increasing the efficiency and effectiveness of intermediated broadcast search leading to more benefits for all parties involved. There has been reluctance in innovating companies to publish how they gained competitive advantage, and product/service launches and resulting revenue generation occur years after their interactions with intermediaries. There is thus a need for case study research as well as large-scale data research to identify best practices in intermediated broadcast search. Detailed research into the effects of engaging in intermediated broadcast search on commercial success and other innovation-related Key Performance Indicators (KPIs) may help innovating companies to better assess the value of these intermediated services for their business and choose the venue that is right for them. While early adopters of open innovation become increasingly knowledgeable with respect to external knowledge searches and intermediaries expand their service offerings to address more refined needs in these large companies it seems that smaller companies are mostly in need of more basic open innovation services that help them to build up experience in external knowledge searching. With their lack of skills and resources the question of how to make intermediated open innovation services accessible and affordable for small companies needs to be answered. Other interesting questions

relate to the topic of group-based problem solving: Are RFPs best written in isolation or with the help of outside parties? Are solution providers best off responding to RFPs by themselves or should they team up with other knowledge parties to provide higher-quality solutions? Although both theory and practice point to the importance of monetary rewards for solution providers in stimulating their participation in markets for solutions more research with respect to the drivers behind solution providers' involvement may shed light on how to attract the most knowledgeable ones.

4.4. Conclusion

My thesis, along with the three research papers, advances the understanding of broadcast search and its processes both at the seeker and at the intermediary. My research work makes clear that introducing and practicing open innovation requires change management at all participants of the two-sided market of open innovation – the innovation seeker, the intermediary, and even the solution provider. With regards to improving the interactions between innovation seeker and the intermediary, my thesis lays down a list of practical actions at the innovation seeker on the one hand, and changes at the intermediary on the other. With the help of two separate research papers I demonstrate that efforts in changing certain internal functioning at the innovation seeker as well as the intermediary can effectively enhance the quality of interactions between them. This in turn leads to better responses from the solution providers, ultimately resulting in overall success from broadcast search. Following these case-study and interview-based research studies, I move on to a more empirical analysis of the functioning of a large number of companies with respect to their open innovation practices. Through this study, and using the organizational change management theory, I highlight the capabilities essential for implementing open innovation, and the sequence in which these capabilities are built by companies. This study further underlines the importance of intermediaries in broadcast search by the finding that services of intermediaries are used by a significant number of companies at early stages of open innovation.

In this way, my thesis shows that intermediaries are an important element in broadcast search and adds to current research on intermediaries and intermediated broadcast search. My research contributes to current understanding on broadcast search and extends it by providing the perspectives of both the innovation seeker and the intermediary.

References

- Afuah, A., & Tucci, C. L. (2012). Crowdsourcing as a solution to distant search. *Academy of Management Review*, 37(3), 355-375.
- Agogué, M., Yström, A., & Le Masson, P. (2013). Rethinking the role of intermediaries as an architect of collective exploration and creation of knowledge in open innovation. *International Journal of Innovation Management*, 17(02), 1-31.
- Alexy, O., George, G., & Salter, A. J. (2013). Cui bono? The selective revealing of knowledge and its implications for innovative activity. *Academy of Management Review*, 38(2), 270-291.
- Almirall, E., & Casadesus-Masanell, R. (2010). Open versus closed innovation: A model of discovery and divergence. *Academy of Management Review*, 35(1), 27-47.
- Antikainen, M. (2011). *Facilitating customer involvement in collaborative online innovation communities*. Ph.D. Thesis. Tampere University of Technology, Tampere, Finland, VTT Publications 760.
- Arora, A., Fosfuri, A., & Gambardella, A. (2001). Markets for technology and their implications for corporate strategy. *Industrial and Corporate Change*, 10(2), 419-451.
- Barrett, C., Musso, C., & Padhi, A. (2010). *R&D after the crisis*. McKinsey Global Survey Report. McKinsey and Company.
- Bessant, J., & Rush, H. (1995). Building bridges for innovation: The role of consultants in technology transfer. *Research Policy* 24, 97-114.
- Billington, C., & Davidson, R. (2013). Leveraging open innovation using intermediary networks. *Production and Operations Management*, 22(6), 1464-1477.
- Bingham, A., & Spradlin, D. (2011). *The open innovation marketplace: creating value in the challenge driven enterprise*. Ft press.
- Boudreau, K. J. & Lakhani K. R. (2009). How to manage outside innovation. *MIT Sloan Management Review*, 50, 69-76.
- Buganza T., D.Chiaroni, G. Colombo, & F. Frattini (2011). Organizational implications of open innovation: an analysis of inter-industry patterns. *International Journal of Innovation Management*, 15(2), S.423–455.
- Ceccagnoli, M., Graham, S. J., Higgins, M. J., & Lee, J. (2010). Productivity and the role of complementary assets in firms' demand for technology innovations. *Industrial and Corporate Change*, 19(3), 839-869.
- Che, Y.K., & Gale, I. (2003). Optimal design of research contests. *American Economic Review*, 93: 646-671.
- Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.) (2006). *Open innovation: Researching a new paradigm*. Oxford, UK: Oxford University Press.
- Chesbrough, H.W. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.

- Chiaroni, D., Chiesa, V., & Frattini, F. (2010). Unravelling the process from closed to open innovation: Evidence from mature, asset intensive industries. *R&D Management*, 40(3), S.222-245.
- Chiaroni, D., Chiesa, V., & Frattini, F. (2011). The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm. *Technovation*, 31, 34–43.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128–152.
- Dahlander, L., & Wallin, M. W. (2006). A man on the inside: Unlocking communities as complementary assets. *Research Policy* 35 (8), S.1243– 59.
- Diener, K., & Piller, F. (2010). *The Market for Open Innovation*. Raleigh, NC: Lulu.
- Diener, K., & Piller, F. (2013). *The Market for Open Innovation*, (2nd ed.). Raleigh, Lulu.
- Dittrich, K. & Duyster, G. (2007) Networking as a means to strategy change: the case of Open Innovation in mobile telephony. *Journal of Product Innovation Management*, 24(6), S.510–521.
- Dushnitsky, G., & Klueter, T. (2011). Is there an eBay for ideas? Insight from online knowledge marketplaces. *European Management Review*, 8, 17-32.
- Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, 39, 311-316.
- Eisenmann, T., Parker, G., & Van Alstyne, M. W. (2006). Strategies for two-sided markets. *Harvard Business Review*, 84(10), 92.
- Fey, C., & Birkinshaw, J. (2005). External Sources of Knowledge, Governance Mode and R&D Performance. *Journal of Management*, 31(4), 597-621.
- Foss, N. J., Laursen, K., & Pedersen, T. (2011). Linking customer interaction and innovation: The mediating role of new organizational practices. *Organization Science*, 22 (4), 980-999.
- Gassmann, O. & Enkel, E. (2004). Towards a Theory of Open Innovation: Three Core Process Archetypes. R&D Management Conference (RADMA) (Lisbon, Portugal).
- Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a Conceptual Framework for Mixed-Method Evaluation Designs. *Educational Evaluation and Policy Analysis*, 11(3), 255–274.
- Hansen, M.T. & Birkinshaw, J. (2007). The innovation value chain. *Harvard Business Review*. June 1.
- Haour, G. (2004). *Resolving the innovation paradox: enhancing growth in technology companies*. London, UK, Palgrave MacMillan.
- Howells, J. (2006). Intermediation and the Role of Intermediaries in Innovation. *Research Policy* 35(5), 715-728.
- Huston, L., & Sakkab, N. (2006). P&G’s new innovation model. *Harvard Business Review*, 84, 58-66.

- Huston, L.A. & Sakkab, N.Y. (2007). Implementing open innovation. *Research Technology Management*, 21-25, March-April.
- Ihl, C., Piller, F., & Wagner, P. (2012). Organizing for open innovation: Aligning internal structure and external knowledge sourcing. Open Innovation: New Insights and Evidence conference, London, June 26.
- Jeppesen, L. B. & Lakhani, K. R. (2010). Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science* 21(5), 1016-1033.
- Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, 33(7), 14–26.
- Judson, A. (1991). In: *Changing behavior in organizations: minimizing resistance to change*. Basil, Blackwell, Cambridge, MA.
- Kirschbaum, R. (2005) Open innovation in practice. *Research-Technology Management*, 48(4), S.24–28.
- Kotter, J. (1995). Leading change: why transformation efforts fail. *Harvard Business Review* 73 (2), S.59–67
- Kouris, I., & Kleer, R. (2012). Business models in two-sided markets: an assessment of strategies for app platforms. International Conference on Mobile Business. Paper 22. <http://aisel.aisnet.org/icmb2012/22>. 2012
- Lakhani K.R. (2006). Broadcast Search in Problem Solving: Attracting Solutions from the Periphery. *Technology Management for the Global Future, PICMET 2006 (Volume 6)*, Istanbul, 2450-2468.
- Lakhani K.R., Jeppesen, L.B., Lohse, P.A., & Panetta, J.A. (2006). The value of openness in scientific problem solving. HBS Working Paper Number: 07-050, Harvard Business School.
- Laursen, K., & Salter, A. J. (2014). The paradox of openness: Appropriability, external search and collaboration. *Research Policy*, 43(5), 867-878.
- Laursen, K., & Salter, A. 2006. Open for Innovation: The Role of Openness in Explaining Innovation Performance among UK Manufacturing Firms. *Strategic Management Journal*, 27, 131-150.
- Lewin, A. Y., Massini, S., & Peeters, C. (2011). Micro foundations of internal and external absorptive capacity routines. *Organization Science*, 22, 81-98.
- Lichtenthaler, U. (2011). Open Innovation: Past Research, Current Debates, and Future Directions. *The Academy of Management Review*, 25(1), 75-93.
- Lichtenthaler, U., & Ernst, H. (2008). Intermediary services in the markets for technology: Organizational antecedents and performance consequences. *Organization Studies*, 29, 1003-1035.
- Luetgens, D., Antons, D., Pollock, P., & Piller, F. (2012). Implementing open innovation beyond the pilot stage: barriers and organizational interventions. RWTH-TIM Working Paper, October.

- Luettgens, D., Pollok, P., Antons, D., & Piller, F. (2014). Wisdom of the crowd and capabilities of a few: internal success factors of crowdsourcing for innovation. *Journal of Business Economics*, 84(3), 339-374.
- Perkmann, M. (2009). Trading off revealing and appropriating in drug discovery: The role of trusted intermediaries. 69th Annual Meeting of the Academy of Management, AOM 2009; Chicago, IL; United States.
- Piller, F. T., & Walcher, D. (2006). Toolkits for Idea Competitions: A Novel Method to Integrate Users in New Product Development. *R&D Management*, 36(3), 307-318.
- Piller, F.T. (2010). From technology market places to problem places. Keynote presentation at Quebec Seeks Solutions. Quebec City, Canada, December 14.
- Rochet, J.C. & Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, 1(4), 990–1029.
- Roijakker, N., Zynga, A., & Bishop, C. (2013). Getting help from innomediaries – what can innovators do to increase value in external knowledge searches? Book chapter in “*Exploring the next wave of open innovation research*” by Chesbrough, H., West, J., Vanhaverbeke, W. In press. Oxford University Press.
- Sakkab, N.Y. (2002). Connect & Develop Complements Research & Develop at P&G. *Research-Technology Management*, 45(2), 38-45.
- Salge T.O., Bohne, T.M., Farchi, T., & Piening, E.P. (2012). Harnessing the value of Open Innovation: The moderating role of Innovation Management. *International Journal of Innovation Management*, 16(3) 1240005 (26 pages).
- Sawhney, M., Prandelli, E., & Verona, G. (2002). The power of innomediation. *MIT Sloan Management Review*, 44(2), 77-82.
- Spradlin, D. (2012). Are you Solving the Right Problem? Asking the Right Questions is Crucial. *Harvard Business Review*, 90(9), 84-101.
- Trott, P., & Hartmann, D. (2009). Why “open innovation” is old wine in new bottles. *International Journal of Innovation Management*, 13(4), 715–736.
- Vega-Jurado, J., Gutiérrez-Gracia, A., & Fernández-de-Lucio, I. (2009). Does External Knowledge Sourcing Matter for Innovation? Evidence from the Spanish Manufacturing Industry. *Industrial and Corporate Change*, 18(4), 637-670.
- Wagner, P. & Piller, F. (2012). Increasing innovative capacity: is your company ready to benefit from open innovation processes? *Ernst and Young Performance Journal*, 4(2).
- West, J., & Bogers, M. (2014). Leveraging external sources of innovation: a review of research on open innovation. *Journal of Product Innovation Management*, 31(4), 814-831.
- Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, 27(2), 185-203

Part B.
Research Papers I-III

Research Paper I:

Getting Help from Innomediaries:

What Can Innovators Do To Increase Value In External Knowledge Searches?

I. Abstract

Several articles have recently arisen on the intermediated open innovation (OI) services offered by innomediaries such as Ninesigma, IXC, InnoCentive, Yet2com, and others and the value that innovating companies can potentially derive from using these intermediated services in each of the phases of their external knowledge searching, i.e. orientation, exploration, selection, and engagement. It turns out, however, that some innovating companies are benefiting more from using intermediated services than others. These differences in the value derived from interacting with innomediaries can partly be linked to the actions innovating companies take internally to add to their potential to generate value. The purpose of this chapter is to identify what innovating companies can do to increase value when they engage with innomediaries in external knowledge searches and thus increase the likelihood of signing beneficial agreements with solution providers.

Keywords: Intermediated OI services, innomediaries, success, value maximization, external knowledge searching

Status:

1. Contribution to edited book: Roijackers, N., Zynga, A., & Bishop, C. (2014). In Chesbrough, H., Vanhaverbeke, W. & West, J. (Eds.). *New Frontiers in Open Innovation*. Oxford: Oxford University Press, 241-257.
2. Presented at: The XXV ISPIM Conference – Innovation for Sustainable Economy & Society, June 8-11 2014. Dublin.

Getting Help from Innomediaries: What Can Innovators Do To Increase Value in External Knowledge Searches?

I.1. Introduction

This chapter aims to show what actions innovating companies can take to increase value when they make use of intermediated OI services in different phases of their external knowledge searching and hence improve their chances of ultimately establishing a successful tech-transfer agreement with a solution provider. Over the past decade more than 25 articles have been written on intermediated services indicating their increasing importance for both academia and practitioners. Some of these publications have been descriptive in nature highlighting important trends in the intermediated OI service industry and describing its main characteristics (see Arora, Fosfuri, and Gambardella, 2001; Enkel, Gassmann, and Chesbrough, 2009). Other studies have focused on the value innovating companies can potentially derive from using intermediated services and have identified the factors (usually outside firms' sphere of influence) that affect the potential value accruing to innovating companies when interacting with innomediaries/solution providers (Dushnitsky and Klueter, 2011; Lichtenthaler and Ernst, 2008) and the motivations behind solution providers' involvement in markets for solutions (Boudreau and Lakhani, 2009; Che and Gale, 2003). Despite this growing body of literature on intermediated services relatively little attention has been paid so far to what innovating companies themselves can do to increase the value they derive from working with innomediaries throughout all phases of external knowledge searches. Some companies are more successful at deriving value from their interactions with innomediaries than others. These differences can partly be linked to the actions innovators take internally to add to their value capturing potential. The objective of this chapter is to identify these internal actions and thus help innovating companies to increase the value they generate when using intermediated OI services.

We can distinguish between two types of innomediaries in the intermediated OI service industry:

1. Innomediaries that offer their intermediated services on the basis of interaction between their staff and the clients they serve and thus rely heavily on experienced personnel. Three subtypes are currently in existence:

- Innomediaries that support innovating companies in their external knowledge searching and find technical solutions that are integrated in the products/services of their clients (e.g. Ninesigma, Innocentive, IXC)
 - Innomediaries that help innovating companies make use of their unused Intellectual Property (IP) (e.g. Yet2.com, Innovaro)
 - Staff-augmentation companies that provide staff to help clients solve OI problems (e.g. IXC, YourEncore)
2. Innomediaries that offer their services on the basis of interaction between innovating companies and technology and thus rely on software programs and search engines. We can distinguish the following three subtypes:
- Platform providers that offer platforms where innovating companies can post their technological needs/offers (e.g. Hypios, IdeaConnection)
 - Software companies that create platforms for ideation/searches (e.g. Inno360, Spigit)
 - Crowd sourcing companies that provide access to consumers (e.g. IdeaScale, Threadless)

In this chapter we study how innovating companies can increase value when interacting with the first type of innomediaries in their external knowledge searches. Innovating companies that make use of intermediated services in external knowledge searching are usually active in highly innovative fields of industry (e.g. automotive, chemicals, consumer packaged goods, food and beverages, pharmaceuticals and medical devices, communications and defense, energy and utilities, electronics) and have a broad technology portfolio that is simultaneously covered by both internal sourcing and external knowledge searches (Cassiman and Veugelers, 2006). Examples of such companies include Philips, Siemens, Glaxo-SmithKline, Kraft, Jaguar Land Rover, Res Med Crown Packaging, PepsiCo, etc. Our exploratory research entails a set of 21 interviews conducted at Ninesigma clients, which were recorded, transcribed, and thematically analyzed resulting in quote sheets categorized by theme. Furthermore, we administered an online survey to 260 innovating companies working with Ninesigma using Survey Monkey. 52 managers at innovating companies (i.e. a response rate of 20%) provided information on their interactions with Ninesigma.

When innovating companies engage in external knowledge searches whilst seeking the help of innomediaries they typically go through four phases: Orientation, exploration, selection, and engagement. In orientation innovating companies join forces with innomediaries to formulate

their technological needs and translate these needs into Requests for Proposals (RFPs). In exploration innovating companies rely on innomediaries to retrieve interesting solution proposals that meet their needs. In the selection phase companies and innomediaries jointly determine the value of submitted proposals and decide which solution provider(s) (if any) to engage with. In engagement innomediaries help their clients to set up meetings with solution providers and sign agreements with these parties (non-disclosure agreements (NDAs) or tech-transfer agreements). While each phase can result in valuable outcomes for innovating companies the process of external knowledge searching is successfully completed once a beneficial agreement with a solution provider is set up. The quality of the intermediated services offered by innomediaries partly influences the likelihood of a signed agreement between their clients and solution providers. However, this represents only one side of the story. Some innovating companies are better equipped to make effective use of intermediated services in their external knowledge searches than others. These variations in success rates can partly be linked to the actions innovating companies take internally to add to their ability to benefit from their interactions with innomediaries. For each of the phases of external knowledge searching we identify a set of actions that innovating companies can take to increase the likelihood of successfully engaging with innomediaries and solution providers. Figure I.1 visualizes the relations between the services offered by innomediaries in each of the phases of external knowledge searching, the value-adding actions by innovating companies, and the key success factors linked to each phase.

On the basis of Figure I.1 the chapter is structured as follows. In the next section we first outline the context of the chapter. We start off by providing an overview of the important literature that has come into existence to date and that focuses on relevant aspects of innomediaries. The second part of this first section deals with the most important trends we currently observe in the intermediated OI service industry. Next, we describe the services offered by innomediaries in each of the phases of external knowledge searching and we explain how Ninesigma clients define success in relation to the help they receive from the innomediary in all phases. In the following, we pinpoint the actions that innovating companies can take for themselves to stimulate value creation in their relations with innomediaries. Finally, we draw conclusions from our exploratory analysis and identify the main venues for future OI research on innomediaries.

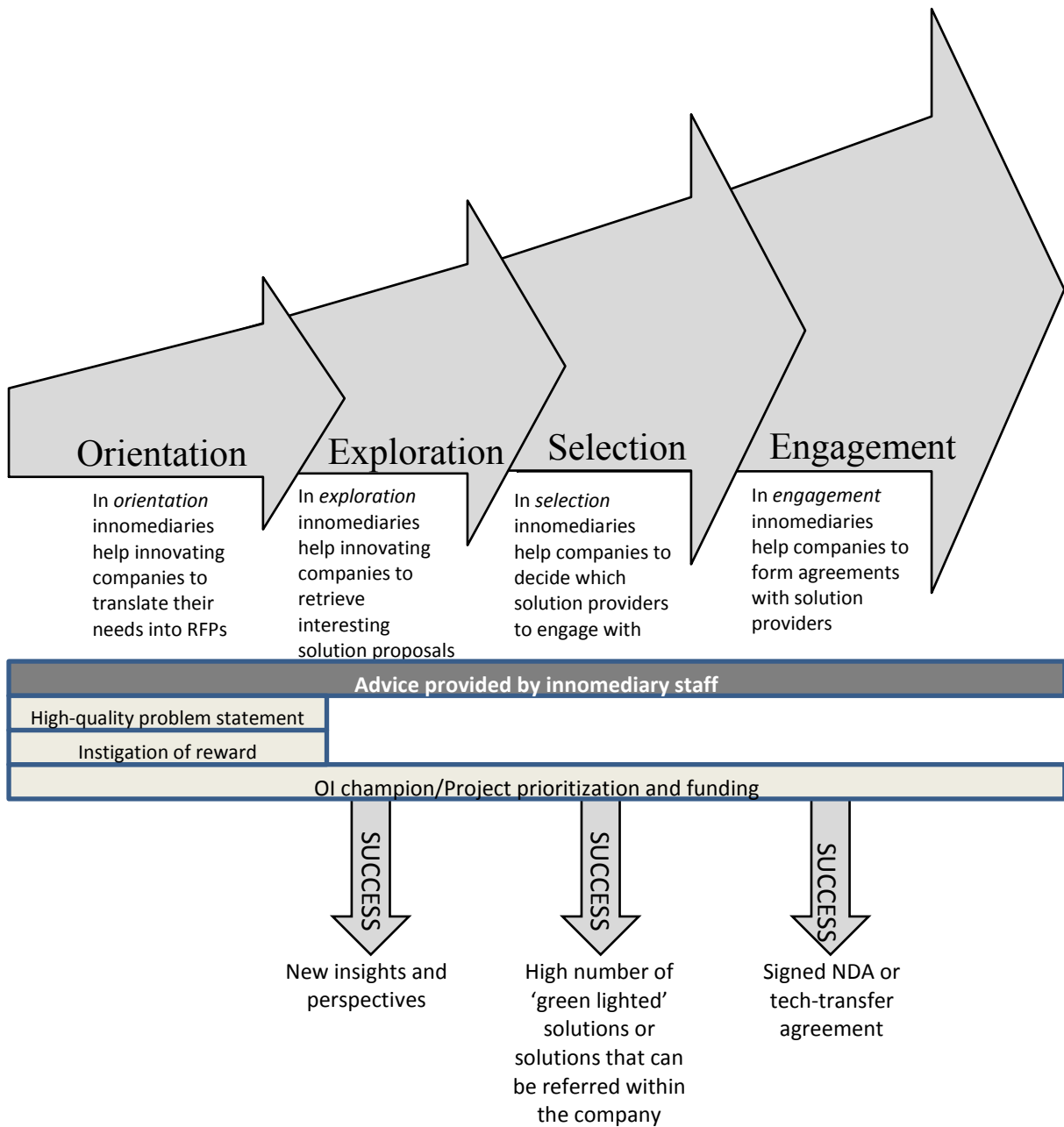


Figure I.1. Potential value added by innomediaries in different stages of external knowledge searches, value-adding actions by innovating companies, and key success factors related to each phase.

I.2. Background on Innomediaries

I.2.1. Theory Development

The increasing importance of the role of innomediaries in helping innovating companies to stimulate their external knowledge searches is witnessed by the growth of academic study in this field. Over 25 publications have arisen in recent years that shed light on innomediaries. Several studies have been published that describe trends occurring in the intermediated OI service industry (Arora et al, 2001; Arora and Gambardella, 2010; Athreye and Cantwell, 2007; Dushnitsky and Klueter, 2011). In 2001 Arora et al were among the first to describe the market for solutions as an effective medium for technology transfer where innovating companies can establish contact with solution providers that offer them resolutions to their internal technical problems. In recent years an increasing number of innovating companies have searched for external knowledge through innomediaries adding significantly to the growth of this marketplace. Specifically, in the mid-1990s the size of the global market for solutions was estimated to comprise around 55-60 billion US dollars in royalty and licensing revenues while this figure grew to around 90-100 billion US dollars in the year 2000 (Arora et al, 2001; Athreye and Cantwell, 2007). Other studies focus on the characteristics and dynamics of the intermediated OI service industry (Enkel et al, 2009; Huston and Sakkab, 2006; Lichtenthaler and Ernst, 2008). Specifically, depending on the number of innovating companies (one or multiple) involved in external knowledge searches markets for solutions have been classified as being either internal to the firm or external (Huston and Sakkab, 2006). As an increasing number of innovating companies have begun to search for knowledge outside their boundaries several innomediaries have come into existence that facilitate the match between innovating companies and solution providers and offer intermediated OI services to firms through their staff (Lichtenthaler and Ernst, 2008). Enkel et al (2009) point out that innomediaries promote external knowledge searches by creating effective bridges between innovating companies and solution providers.

Other authors have described the role played by innomediaries in helping companies to search for external knowledge (Arora and Fosfuri, 2003; Lichtenthaler and Ernst, 2008; Nambisan and Sawhney, 2007; Tapscott and Williams, 2006). Lichtenthaler and Ernst (2008) stress that innomediaries help their clients to formulate effective problem statements in RFPs thus enhancing the likelihood of obtaining high-quality solutions from solution providers (Sieg, Wallin, and von Krogh, 2010). Others focus on the factors affecting the value that innovating companies can potentially derive from interacting with innomediaries and solution providers, such as the not-invented-here syndrome (NIH), a low level of absorptive capacity, a lack of

complementary knowledge/assets, and tacit knowledge components (Arora and Gambardella, 2010; Bresnahan and Trajtenberg, 1995; Ceccagnoli, Graham, Higgins, and Lee, 2010; Dushnitsky and Klueter, 2011; Gans and Stern, 2010). The NIH syndrome refers to the unwillingness in innovating companies to engage in external knowledge searches and a clear preference for internal knowledge development. Typically this opposition is grounded in the organizational culture of innovating companies (Arora and Gambardella, 2010). A low level of absorptive capacity (Cohen and Levinthal, 1990) in innovating firms is related to the underdeveloped capacity in some companies to make use of external knowledge, which discourages their efforts to engage with innomediaries. Some solution proposals tend to be more valuable when innovating companies are able to combine these technical resolutions with internal complementary assets and knowledge components. Not all innovating companies possess these important complementary skills, which leads them to derive less value from their external knowledge searches (Bresnahan and Trajtenberg, 1995; Ceccagnoli et al, 2010). If solution proposals involve tacit knowledge components it is very difficult for innovating companies to appreciate the value of these proposals or apply this knowledge within their business (Dushnitsky and Klueter, 2011).

A final stream of research is focused on issues related to solution providers. Some authors point out that a high number of solution providers responding to RFPs may decrease the quality of solutions as solution providers are less likely to invest large amounts of resources if the chance of winning is low (Che and Gale, 2003; Taylor, 1995). Others argue that a higher number of solution providers adds to the diversity of solutions thus offsetting possible negative effects (Pisano and Verganti, 2008; Terwiesch and Ulrich, 2009; Terwiesch and Xu, 2008). Silveira and Wright (2010) examine the ambiguous role of IP in the intermediated OI service industry where innovating companies need access to full information to rightfully assess the value of solution proposals while solution providers look for ways to protect their knowledge through IP (Laursen and Salter, 2012). Few studies examine the drivers behind solution providers' involvement in markets for solutions and conclude that monetary rewards are important motivators besides softer motivations such as personal enjoyment (Boudreau, Lacetera, and Lakhani, 2011; Boudreau and Lakhani, 2009; Frey, Lüthje, and Haag, 2011; Lakhani and Jeppesen, 2007).

I.2.2. Trends in Practice

There is increased acceptance in large companies that OI is an essential part of their business. Early adopters of OI such as Philips, Kraft, and PepsiCo have learned from their experiences and

have consequently refined their use of OI (Cassiman and Veugelers, 2002; Chesbrough, 2003, 2006; Laursen and Salter, 2006). They have moved from exploring technological solutions through traditional partnerships to multi-party collaborations. This is particularly the case where companies recognize the need to work with universities and a multitude of other partners at the same time. An example of this is the San Diego Zoo Global Bioinspiration program where biologists, engineers, and chemists join forces to solve problems in the areas of technology, transportation, and renewable energy. The more refined OI practice of large companies also becomes clear from their current use of crowd sourcing, which has evolved from writing RFPs based on a few predefined search criteria to setting up competitions in areas where they need to rapidly acquire new knowledge and build partnerships (e.g. Siemens Smart Grid Contest 2010). Furthermore, most early adopters of OI no longer view crowd sourcing and technology scouting as OI actions in themselves but more so as part of the day-to-day job of all members of their R&D teams. A final piece of evidence with respect to the increased refinement of large companies in OI relates to their objectives for external knowledge searches that have broadened out from in-licensing to acquisitions, joint ventures, joint development agreements, and collaborations to secure government funding of development programs. As a result of their increased sophistication in OI and their increased reliance on internal staff for technology scouting early adopters typically rely on innomediaries for external knowledge searches outside their normal field of view or to provide staff as an interim resource to handle specialist OI projects or peaks in workload.

In small innovators we witness increasing recognition of the importance of OI and strong efforts to engage in OI. Particularly, the more the small innovator makes use of complex technologies the more it is likely to use OI for product improvement, cost reductions, solving technology challenges, new product and service development, and opening up new markets. However, a lack of skills and resources as well as a short-term focus seem to restrict the scope for OI action in small companies (Chesbrough, 2011; Dahlander and Gann, 2010; Freel, 2000; Gans and Stern, 2003; Laursen and Salter, 2006; Lee, Park, Yoon, and Park, 2010; Narula, 2004; Spithoven, Vanhaverbeke, and Roijakkers, 2012; Van de Vrande, De Jong, Vanhaverbeke, De Rochemont, 2009). In order to spur their innovation activities small innovating companies seem to continue relying on interaction with universities. When they do make use of intermediated OI services small firms are more likely to engage with individual consultants rather than innomediaries.

Increased interest in OI among all types of companies and a heightened refinement in the use of OI in large companies have expanded the market for innomediaries and encouraged new

entrants (Diener and Piller, 2010). OI is a people intensive process and whilst techniques such as crowd sourcing now make it much easier to find data, people are still needed to make sense of what is found. Hence, many innomediaries have increased their focus on supplying hard to replicate analytical and soft people skills for OI to ward off competition. Ninesigma, Innocentive, IXC, Yet2.com, and YourEncore have expanded their services to now cover advice not only in the orientation and exploration phases of external knowledge searching, which were traditionally the phases where innomediaries would offer their services, but also in selection and engagement (see Figure I.1). Innomediaries nowadays provide OI consultancy through their staff throughout all phases of external knowledge searching and stimulate companies to take actions for increasing the value they can derive from using intermediated OI services (e.g. recruiting, training, and appointing OI champions).

I.3. External Knowledge Searches: What Innovating Companies Perceive As Successful Outcomes of Intermediated OI Services

A number of studies describe the intermediated OI services offered by innomediaries in external knowledge searches (Mortara, 2010). Few researchers have paid attention to what constitutes a successful outcome of interactions between innomediaries and their clients. Most observations in this respect are of a general nature where researchers mention that value pertains to lower internal R&D costs, reduced R&D risks, shorter time-to-market, and access to new ideas (Arora et al, 2001; Enkel et al, 2009; Lichtenthaler and Ernst, 2008). In this section we describe the intermediated OI services offered by innomediaries and we link these intermediated services to the various phases that innovating companies typically go through when searching for technological knowledge outside their boundaries. Furthermore, we specify what constitutes a successful interaction with an innomediary in each phase as perceived by Ninesigma clients (see Figure I.1).

In orientation the intermediated services of innomediaries are focused on helping their clients to understand and formulate their technological needs as well as coaching them to write RFPs that contain high-quality problem statements. One of the most difficult facets of writing RFPs is associated with formulating problem statements that adequately cover the innovating company's technological needs. The quality of the problem statement in an RFP (in terms of pinpointing the precise technological problem) determines the quality of the solutions that are offered by solution providers (in terms of the extent to which the proposed solution meets the technical needs of the innovating company) (Lichtenthaler and Ernst, 2008; Sieg et al, 2010). Interviewees mention the following in relation to intermediated OI services in this phase: "(...) Ninesigma asks questions

that force us to think carefully about the problem we are trying to solve (...) they work with us on defining the problem (...)"

In the exploration phase innomediaries facilitate the retrieval of new and unexpected technology solutions. Based on their network of technology companies, universities, research institutes, etc. they are able to invite solution providers to respond to their clients' specific technological needs. As such innomediaries help their clients obtain proposals from parties that they might not have considered as relevant technology sources or that they might not have been able to reach otherwise. Managers at innovating companies phrase this as follows: "(...) Ninesigma can use its platform to identify thousands of engineers working on particular research problems and within a couple of weeks we know whether to continue or terminate a project (...) they provide us with information regarding possible solutions and solution providers that we could not find on the internet or in the scientific literature. We could have been searching forever and never found them (...)". The exploration phase is considered to be successful by Ninesigma clients when they are able to gain access to new insights and perspectives with respect to their internal problem-solving initiatives through their use of intermediated OI services. An interviewee described this successful outcome in the following manner: "(...) through Ninesigma we get exposed to companies with different views (...) different perspectives or angles that we did not consider before and sometimes this leads us to re-evaluate our projects (...)".

In the selection phase innomediaries offer services that aid innovating companies in selecting valuable solution proposals. When solution providers submit possible technical answers to problem statements that were worded in RFPs innovating companies have to determine the value of these solutions. Furthermore, they need to decide whether or not to engage in further interactions with solutions providers. Innomediaries capture and deliver information that their clients need to make such difficult decisions. In addition, they provide methods and tools to assist in the decision-making process. When working with innovating companies Ninesigma makes use of a traffic light system to recommend and prioritize solution proposals meeting companies' original objectives where 'green lighted' solutions represent the most valuable solutions in terms of meeting technical specifications. As one client put it: "(...) Ninesigma ranks solutions based on relevant criteria that allow us to prioritize the top responses (...)". In selection Ninesigma clients perceive a high number of 'green lighted' solutions as a successful outcome of their interaction with the innomediary. One interviewee states that: "(...) it is not just about the number of solutions we receive (...) it is about the number of solutions we find useful (...)". Another successful outcome in selection is the number of solution proposals that can be referred to other departments within the client organization. Sometimes innovating companies receive solution

proposals that are not directly relevant for the team/department that got involved with the innomediary in the first place. In these cases proposals may get transferred within the company to other teams/departments working on different sets of technological problems benefitting more directly from the proposed solutions. As one manager put it: “(...) it was not directly of use to us (...) so we knew of some scientists within our company working on such issues (...) we sent it to them and they could use it (...)”.

In engagement innomediaries help to bring about agreements between their clients and solution providers that were selected in the previous phase. Innomediaries assist their clients in conducting negotiations with solution providers and help to set up NDAs to stimulate further technological discussions and more definitive arrangements pertaining to the transfer of technological knowledge/IP or joint knowledge creation. Ninesigma clients describe this service as follows: “(...) Ninesigma facilitated interaction with a solution provider, which allowed us to communicate through face-to-face talks and clarify those nuances that came out of telephone conversations and were still unsolved (...)”. Innovating companies perceive this phase to be successful when they sign a beneficial NDA or a tech-transfer agreement with a solution provider. One interviewee mentioned the following in this respect: “(...) for me a successful project is the one that ends in a signed agreement for further cooperation (...)”.

Throughout all phases of external knowledge searching innomediaries rely on their staff to provide clients with technical advice and OI consulting where necessary. One of the interviewees referred to this service aspect in the following manner: “(...) we have had discussions with Ninesigma project managers to describe our needs (...) they capture what we need and then translate that need to make it work for their network of solution providers (...)”.

I.4. External Knowledge Searches: What Innovators Can Do To Increase Value from Using Intermediated OI Services

Clients’ perceptions of successful outcomes of using intermediated OI services are linked to different phases of external knowledge searching. The successful completion of this search process is evidenced by a signed agreement between innovating companies and solution providers. This valuable end result is by no means an isolated outcome as it builds on the results obtained in previous phases: A high-quality RFP with a well-defined problem statement is likely to attract a high number of interesting solution providers resulting in a high number of ‘green lighted’ solution proposals. A high number of valuable technical solutions positively affect the

chances of successful negotiations between innovating companies and solution providers. Being successful in each of the phases of external knowledge searching whilst joining forces with an innomediary partly hinges on the quality of the intermediated OI services offered by the innomediary; it is also partly dependent on the ability of the client to make effective use of these intermediated services. Some innovating companies have a higher likelihood of signing an NDA or a tech-transfer agreement with solution providers than others following their interaction with innomediaries. Broadly we can say that for less successful innovating companies, which have a signed agreement as one of their main targets, around 40% of their RFPs lead to a signed agreement whereas more successful companies, targeting a signed agreement, are able to turn 60%-70% of all their external knowledge searches through RFPs into successful contracts. These differences in success rates can be linked to the actions innovating companies take internally to add to their ability to make effective use of intermediated services in each phase thus increasing their chances of signing an agreement with a solution provider in engagement (Ihl, Piller, and Wagner, 2012). In this section we identify the actions innovating companies can take in different phases of their external knowledge searches to increase their chances of success (see Figure I.1).

To increase value from using intermediated services innovating companies need to develop skills with respect to rightly formulating problem statements and writing up high-quality RFPs. In orientation one of the main challenges is defining a high-quality problem statement (Lichtenthaler and Ernst, 2008; Sieg et al, 2010). If the problem statement contains more than one technical issue, there is a high likelihood that very few solution providers will respond to the RFP. If the problem statement is too descriptive in terms of applications solution providers from industries other than the innovating company's may fail to address the problem or offer their solutions. Innovating companies with the skills and experience necessary for translating their technical needs into specific problem statements tend to be more effective in teaming up with an innomediary and jointly developing an RFP. Ninesigma clients mention the following in this respect: "(...) it is all about how you craft the RFP (...) formulating a problem statement that is free of industry language is of eminent importance (...)". Another important action that innovating companies can take to be more effective in their interactions with innomediaries is to instigate a reward for successful solutions in the orientation phase. Most of the successful innovating companies make available a financial reward for solution providers that present them with valuable solutions. The amount of the reward available for a solution provider should be proportional to the potential value created through the successful solution. There is a high correlation between the reward offered by an innovating company and the likelihood that this company will ultimately sign a mutually beneficial agreement with a solution provider either to engage in further negotiations or to transfer knowledge from the solution provider to the

innovating company (Boudreau et al, 2011; Boudreau and Lakhani, 2009; Frey et al, 2011; Lakhani and Jeppesen, 2007). As one interviewee put it: “(...) the financial incentive shows that you are serious and willing to spend money to solve a problem (...)”.

To stimulate more effective interactions with innomediaries throughout all phases of external knowledge searching innovating companies need to appoint an OI champion to support the project as well as label the project as ‘strategic’ and fund it as such. Innovating companies that effectively make use of intermediated OI services experience very strong support for OI initiatives and intermediated services from the very top levels of their organization. Most of these companies have an OI champion in place when interacting with innomediaries. An OI champion is typically an experienced, high-status individual who is well-connected within the innovating firm and is empowered to manage all phases of external knowledge searching. Innovating companies interacting with Ninesigma describe the role of an OI champion in the following manner: “(...) the champion is an early point of contact for outside companies (...) the champion preaches the OI mentality (...) the champion is cheerleader, coach, strategist, organizer, maintainer of the OI philosophy (...)”. When all phases of external knowledge searching are driven by a champion, the success rate doubles and triples compared to companies that do not have such executive support. As one interviewee stated: “(...) this whole process has been supported by senior management; otherwise it simply would not happen (...)”. Furthermore, innovating companies that are most effective in signing agreements with solution providers typically designate their OI projects and their engagements with innomediaries as ‘strategic’. Strategic projects are a corporate priority and are not likely to be cancelled due to changing corporate agendas. When an innovating company uses the most strategic projects for external knowledge searches that have certain urgency about them, chances for success go up dramatically. In the interview phase we found that “(...) the main reason why projects do not succeed is because they are not strategically relevant to the company (...)”. Another Ninesigma client mentioned that “(...) senior management has to provide long-term financial support (...) you have to have full engagement of internal resources (...) for it to be successful (...)”.

I.5. Conclusions and Venues for Further Research

On the basis of interviews and survey research among Ninesigma clients this chapter has shown that there are several actions innovating companies can themselves take to increase value from interacting with innomediaries in all phases of their external knowledge searching. More and more innovating companies with broad technology portfolios in automotive, pharmaceuticals and

medical devices, communications and defense, and other sectors of industry make use of intermediated OI services to stimulate their external knowledge searches. While these typically large companies (early adopters such as Siemens, Glaxo-SmithKline, and Jaguar Land Rover) have gained substantial experience in OI and the use of sophisticated OI tools, innomediaries have intensified their service offerings in the initial phases of external knowledge searching and expanded their activities to also cover intermediated services in the final phases of external searches and OI consultancy in all phases. In recent years several interesting publications have emerged describing the role played by innomediaries in the external knowledge searches of large innovating companies (Enkel et al, 2009; Lichtenthaler and Ernst, 2008). While some authors (Ceccagnoli et al, 2010) have identified a number of factors influencing the potential value innovating companies can derive from using intermediated OI services these factors are mostly difficult to change or beyond the direct sphere of influence of most companies. Building on a few other studies (Boudreau and Lakhani, 2009; Lakhani and Jeppesen, 2007; Lichtenthaler and Ernst, 2008; Ihl et al, 2012) in this chapter we focus on what innovating companies can do internally to increase the likelihood of success when engaging with innomediaries.

Our exploratory research identifies several routes to improving the chances of success when engaging in external knowledge searches: Optimizing the RFP writing process; rewarding solution providers that add value to internal problem-solving; appointing an experienced, high-profile OI champion to stimulate external knowledge searches; prioritizing OI projects and allocating long-term funding to these initiatives. What is interesting about these results is that there is a specific set of actions that innovating companies can take at the very beginning of their external knowledge searching, that is before even putting out an RFP (defining a high-quality problem statement and making mention in the RFP of a reward coupled to receiving valuable solutions), which significantly increase the likelihood of engaging with solution providers in the final stage of external knowledge searching.

On its website Ninesigma hosts an OI scorecard diagnostic tool that captures companies' OI adoption rates or maturity level. Of the companies visiting this website (not necessarily clients of Ninesigma) and providing input to the tool 34% are not involved in OI at the moment; 37% of all respondents report to be in the early stages of OI; 23% of companies are currently optimizing an existing OI program; 6% are re-launching an OI program. From these figures we can conclude that although there are several large innovating companies with a fairly high level of experience in OI and highly sophisticated OI programs in place, there are also many (small) companies that are only just beginning to learn about the potential benefits related to engaging in external knowledge searches. For all of these innovating companies (both experienced and inexperienced

at OI) aiming to learn about new technologies through using intermediated OI services it is of utmost importance to realize that there are several actions they can take themselves, such as building skills in the RFP writing process and appointing an OI champion, to significantly add to the value they can potentially derive from using these intermediated services (Enkel, Bell, and Hogenkamp, 2011; Ihl et al, 2012).

We discern several venues for further research by OI scholars targeted towards increasing the efficiency and effectiveness of intermediated OI services in all phases of external knowledge searching leading to more benefits for all parties involved. Several case studies in intermediated OI services have emerged over time. However, they have lagged behind practice due to reluctance in innovating companies to publish how they gained competitive advantage and due to the fact that product/service launches and resulting revenue generation occur years after their interactions with innomediaries. There is thus still a need for case study research as well as large-scale data research to identify best practices in intermediated OI services. Detailed research into the effects of engaging in intermediated OI services on commercial success and other innovation-related Key Performance Indicators (KPIs) may help innovating companies to better assess the value of these intermediated services for their business and choose the venue that is right for them. While early adopters of OI become increasingly knowledgeable with respect to external knowledge searches and innomediaries intensify their service offerings to address more refined needs in these large companies it seems that smaller companies are mostly in need of more basic OI services that help them to build up experience in external knowledge searching. With their lack of skills and resources the question comes to mind of how to make intermediated OI services accessible and affordable for small companies. As an increasing number of innomediaries intensify their service offerings to include OI consultancy, the question arises which business model is most appropriate to commercialize these new intermediated services. As large companies become more experienced at external knowledge searches they develop their own competitions to attract solution providers. How does this development affect innomediaries? Other interesting questions relate to the topic of group-based problem solving: Are RFPs best written in isolation or with the help of outside parties? Are solution providers best off responding to RFPs by themselves or should they team up with other knowledge parties to provide higher-quality solutions? Although both theory and practice point to the importance of monetary rewards for solution providers in stimulating their participation in markets for solutions more research with respect to the drivers behind solution providers' involvement may shed light on how to attract the most knowledgeable ones.

I. References

- Arora, A., & Fosfuri, A. (2003). Licensing the market for technology. *Journal of Economic Behavior & Organization*, 52(2), 277-295.
- Arora, A., & Gambardella, A. (2010). Ideas for rent: an overview of markets for technology. *Industrial and Corporate Change*, 19(3), 775-803.
- Arora, A., Fosfuri, A., & Gambardella, A. (2001). Markets for technology and their implications for corporate strategy. *Industrial and Corporate Change*, 10(2), 419-451.
- Athreye, S., & Cantwell, J. (2007). Creating competition? Globalization and the emergence of new technology producers. *Research Policy*, 36(2), 209-226.
- Boudreau, K. J., Lacetera, N., & Lakhani, K. R. (2011). Incentives and problem uncertainty in innovation contests: An empirical analysis. *Management Science*, 57(5), 843-863.
- Boudreau, K. J. & Lakhani K. R. (2009). How to manage outside innovation. *MIT Sloan Management Review*, 50, 69-76.
- Bresnahan, T. F., & Trajtenberg, M. (1995). General purpose technologies 'Engines of growth'? *Journal of Econometrics*, 65(1), 83-108.
- Cassiman, B., & Veugelers, R. (2002). R&D cooperation and spillovers: some empirical evidence from Belgium. *American Economic Review*, 1169-1184.
- Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science*, 52(1), 68-82.
- Ceccagnoli, M., Graham, S. J., Higgins, M. J., & Lee, J. (2010). Productivity and the role of complementary assets in firms' demand for technology innovations. *Industrial and Corporate Change*, 19(3), 839-869.
- Che, Y.K., & Gale, I. (2003). Optimal design of research contests. *American Economic Review*, 93: 646-671.
- Chesbrough, H.W. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.
- Chesbrough, H. (2006). Open innovation: a new paradigm for understanding industrial innovation. In Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). *Open innovation: researching a new paradigm*. Oxford University Press, Oxford, 1-12.
- Chesbrough, H. (2011). *Open services innovation: Rethinking your business to grow and compete in a new era*. Jossey-Bass, San Francisco.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35, 128-152.
- Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research policy*, 39(6), 699-709.
- Diener, K., & Piller, F. (2010). *The Market for Open Innovation*. Raleigh, NC: Lulu.
- Dushnitsky, G., & Klueter, T. (2011). Is there an eBay for ideas? Insight from online knowledge marketplaces. *European Management Review*, 8, 17-32.

- Enkel, E., Bell, J., & Hogenkamp, H. (2011). Open innovation maturity framework. *International Journal of Innovation Management*, 15(06), 1161-1189.
- Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, 39, 311-316.
- Freel, M. S. (2000). Barriers to product innovation in small manufacturing firms. *International Small Business Journal*, 18(2), 60-80.
- Frey, K., Lüthje, C., & Haag, S. (2011). Whom should firms attract to open innovation platforms? The role of knowledge diversity and motivation. *Long Range Planning*, 44(5), 397-420.
- Gans, J. S., & Stern, S. (2010). Is there a market for ideas? *Industrial and Corporate Change*, 19: 805-837.
- Huston, L., & Sakkab, N. (2006). P&G's new innovation model. *Harvard Business Review*, 84, 58-66.
- Ihl, C., Piller, F., & Wagner, P. (2012). Organizing for open innovation: Aligning internal structure and external knowledge sourcing. Open Innovation: New Insights and Evidence conference, London, June 26.
- Lakhani, K. R., & Jeppesen, L. B. (2007). R&D: Getting unusual suspects to solve R&D puzzles. *Harvard Business Review*, 85(5), 30-32.
- Laursen, K., & Salter, A. 2006. Open for Innovation: The Role of Openness in Explaining Innovation Performance among UK Manufacturing Firms. *Strategic Management Journal*, 27, 131-150.
- Laursen, K., & Salter, A. (2012). The paradox of openness: Appropriability and the use of external sources of knowledge for innovation. Open Innovation: New Insights and Evidence conference, London, June 26.
- Lee, S., Park, G., Yoon, B., & Park, J. (2010). Open innovation in SMEs—an intermediated network model. *Research policy*, 39(2), 290-300.
- Lichtenthaler, U., & Ernst, H. (2008). Intermediary services in the markets for technology: Organizational antecedents and performance consequences. *Organization Studies*, 29, 1003-1035.
- Mortara, L. (2010). Getting help with open innovation. University of Cambridge Press, Cambridge.
- Nambisan, S., & Sawhney, M. (2007). *The global brain: your roadmap for innovating faster and smarter in a networked world*. Wharton School Publishing, Philadelphia.
- Narula, R. (2004). R&D collaboration by SMEs: new opportunities and limitations in the face of globalization. *Technovation*, 24(2), 153-161.
- Pisano, G. P., & Verganti, R. (2008). Which kind of collaboration is right for you? *Harvard business review*, 86(12), 78-86.
- Sieg, J. H., Wallin, M. W., & Von Krogh, G. (2010). Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. *R&D Management*, 40(3), 281-291.

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- Silveira, R., & Wright, R. (2010). Search and the market for ideas. *Journal of Economic Theory*, 145(4), 1550-1573.
- Spithoven, A., Vanhaverbeke, W., & Roijackers, N. (2013). Open innovation practices in SMEs and large enterprises. *Small Business Economics*, 41(3), 537-562.
- Tapscott, D., & Williams, A. D. (2006). *Wikinomics: How mass collaboration changes everything*. Penguin, London.
- Taylor, C. R. (1995). Digging for golden carrots: an analysis of research tournaments. *The American Economic Review*, 872-890.
- Terwiesch, C., & Ulrich, K. T. (2009). *Innovation tournaments: Creating and selecting exceptional opportunities*. Harvard Business School Publishing, Boston.
- Terwiesch, C., & Xu, Y. (2008). Innovation contests, open innovation, and multi-agent problem solving. *Management Science*, 54(9), 1529-1543.
- Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, 29(6), 423-437.

Research Paper II:

Beyond Pricing Decisions: Business Model Innovation in the Two Sided Market of an Open Innovation Intermediary

II. Abstract

One specific method of gaining access to technologies and expertise has emerged with the creation of "open innovation marketplaces" since about the year 2000. Such marketplaces are usually run by Intermediaries – specialized firms that provide professional knowledge search expertise to companies seeking knowledge or innovations. Intermediaries operate as a platform provider that enables interaction between two networks that value each other's presence – the Innovation Seekers and the Solution Providers. This study focuses on the two-sided business model of OI intermediary NineSigma, and specifically their technology search process that is typically done in the form of an open broadcast search (Jeppesen and Lakhani, 2010). In order to analyze how business model changes impact the success of different market sides of an Open Innovation Intermediary that operates in a two sided market we designed a multi-method approach: The qualitative research approach allowed us to gain good access to NineSigma's business model structure and process; especially interviews and workshops with Service staff and the CEO of NineSigma that has been with NineSigma since the inception of the business. However we also address quantitatively why and how certain service elements have evolved based on decisions made through learnings, and illustrate specific cases where these decisions have influenced the overall outcome of the technology search process on both networks (and market sides). The paper provides insights threefold:

- 1) The paper overall gives a detailed overview about the working of an intermediary business, and the innovations taking place in their business model.
- 2) The paper points out the intermediary service elements that have had significant impact on overall success of open innovation process of their innovation seeking clients.
- 3) Finally, this paper identifies that in reports on success with open innovation involving intermediaries, the focus has always remained on either the innovating company, or the Solution Provider, whereas the functioning of the intermediary has always been taken as a

static element. The paper points out that the functioning of the intermediary – an important link in the open innovation process – is dynamic, and is continuously evolving, so as to improve success rates of its clients' open innovation endeavors

Keywords: Intermediated OI services, intermediaries, success, two sided market, business model innovation

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Beyond Pricing Decisions: Business Model Innovation in the Two Sided Market of an Open Innovation Intermediary

II.1 Introduction

Open Innovation is a way for organizations to go beyond their own four walls in order to find, or inspire new knowledge, ideas, and technologies (Chesbrough, 2003). One specific method of gaining access to technologies and expertise has emerged with the creation of "open innovation marketplaces" since about the year 2000. Such marketplaces are usually run by Intermediaries – specialized firms that provide professional knowledge search expertise to companies seeking knowledge or innovations.

It has been widely acknowledged that innovation intermediaries play an important role in developing, accelerating, and controlling the knowledge and dynamic competences necessary to solve complex innovation problems, and in fostering the diverse linkages between various geographically dispersed entities or innovation networks (Howells, 2006; Boudreau and Lakhani, 2009; Luettgens et al., 2012; Roijakkers et al., 2014).

The role of the intermediary is thus more than that of a mere technology broker. Open Innovation service intermediaries are professional bodies that make significant contributions to the overall success of the open innovation process by continuously reflecting upon their own internal processes, and improving them by means of customer feedback, and extant competitive and market pressures.

It is hence imperative that studies on success with open innovation that involve intermediaries not assume the intermediary as a black-box and a static element, but look at the various aspects and systemic evolution of the functioning of the intermediary over the time frame under study, and how such changes have influenced success. This would help in providing a normalized reference for sampling and analysis of the data used for the empirical and/or case studies. Further research into the evolution of the service elements developed by intermediaries, and the impact of this evolution on their success with searches ("Search Success") still needs to be done and is one of the results of this paper. The term "Search Success" itself has many variants (Roijakkers et al., 2014), and in the context of this paper it is defined as a solution submitted by a solution provider that the innovation seeker accepted in the form of a contract for transfer of intellectual property.

Intermediaries operate as a platform provider that enables interaction between two networks that value each other's presence – the Innovation Seekers and the Solution Providers. Thus, intermediaries operate under the framework of two-sided markets (Rochet and Tirole, 2003). This study focuses on the two-sided business model of OI intermediary NineSigma, and specifically their technology search process that is typically done in the form of an open broadcast search (Jeppesen and Lakhani, 2010).

The current literature on two-sided market models is focused on the analysis of "optimal" pricing for both market sides (Eisenmann et al., 2006; Kouris and Kleer, 2012). This is clearly of importance for the success of intermediaries in general, and NineSigma specifically as well. However, current studies on two-sided markets see the quality of service as a fixed parameter, which in the case of NineSigma is clearly not indicated as will be shown. Business model innovation is not just about pricing, but also service innovation; and to the best of our knowledge, no one has looked at the impact of service innovations on the overall success of an intermediary.

This suggests the following research question:

"How do business model changes impact the success of different market sides of an Open Innovation Intermediary that operates in a two sided market?"

When considering "success" in the context of intermediaries in general, and in this paper specifically, it is important to distinguish between the different dimensions of "success". There is the success of an individual technology search done by an intermediary defined above as Search Success. However, there is also the economic / financial success of the intermediary itself (hereinafter called "Intermediary Success"), as well as the financial / economic success of the Innovation Seeker side ("Seeker Success"), and the financial / economic success of the Solution Provider that submits solutions as a result of Broadcast Searches ("Provider Success") This is important since business model decisions made by intermediaries will have an impact on all those dimensions as will be shown in this paper.

This study is structured as follows. We will first develop the theoretical framework for this paper by looking at the intermediary as a research subject, both from the point of view of the external environment, and then the internal functioning of Open Innovation intermediaries. We will continue developing the theoretical framework by reviewing literature on the two sided market model. Thereafter, we will introduce the case for this paper, open innovation intermediary NineSigma, followed by a description of the scientific approach, and the data sources. We will

then present the results in detail, and close with a contextual review of results, a summary, and a few words on limitations of this paper, as well as recommendations for further research.

II.2. Theoretical Framework

II.2.1. The Intermediary as a Research Subject

II.2.1.1. External Environment

In the early days, when the market for intermediaries practicing systematic open innovation was relatively new, competitive pressures were low, and the only requirement for intermediaries was to provide a consistent and high quality of services. As open innovation started gaining popularity, more organizations started utilizing the services of intermediaries, the number of Solution Providers responding to calls for proposals increased, and there was an increasing external pressure to improve Search Success, and to provide additional service elements that respond to needs of each side of the network. This is particularly true for the "Early Adopters" of open innovation, whose use of open innovation tools was maturing rapidly. Some of the early adopters of Open Innovation were Procter&Gamble, DSM, and General Mills. They were quickly followed by Philips, Unilever, Kraft Foods and many more. Additionally, as more companies adopted the Open Innovation approach, more Open Innovation Intermediaries entered the market: Following OI pioneers NineSigma, InnoCentive and Yet2.Com were many others as shown in Figure II.1 below.

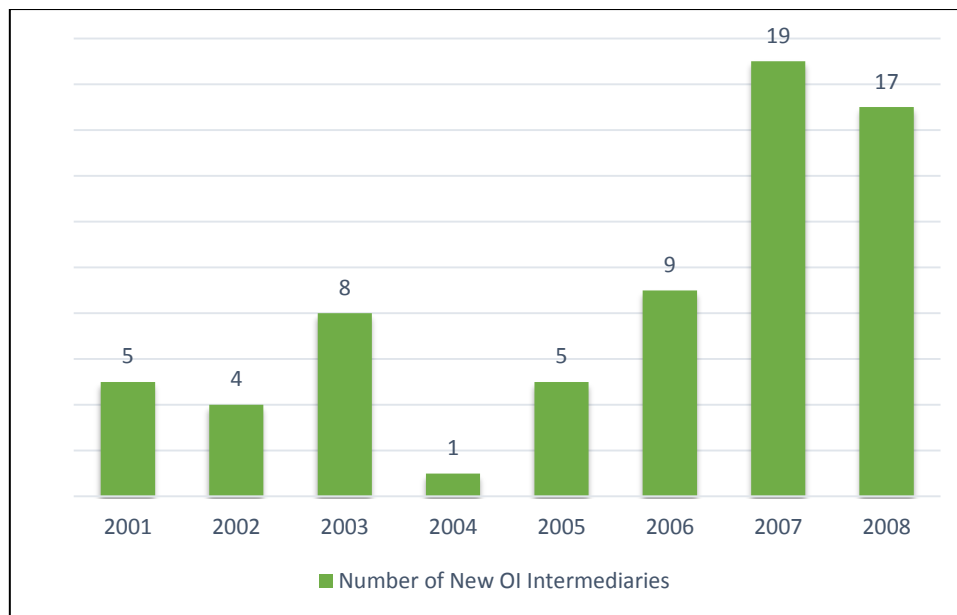


Figure II.1. New entrants in the open innovation marketplace (from Diener and Piller, 2013).

Now there are more than 160 players, and the market has become quite complex (Diener and Piller, 2013). The open innovation market had a significant peak during 2004-2006, when the market recorded 100% growth, mainly due to the diffusion of first success stories in the open innovation field from companies such as P&G (Huston and Sakkab, 2006; Diener and Piller, 2013). A recent market study by Diener and Piller (2013) reveals that the market for open innovation is getting mature. In a McKinsey Global Survey on innovation and commercialization, 69% of the 2240 respondents surveyed acknowledged that their organization was effectively using partnerships and open innovation to drive innovation (Capozzi et al., 2010). Another McKinsey Global Survey points out that following the economic downturn in 2009, a significant number of companies have increased their focus on collaborating with outside R&D groups and increasing the use of global R&D resources, as an effort to increase discipline and reduce R&D costs within their organization (Barrett et al., 2010). The estimated market size for intermediated open innovation in 2013 was pegged at Euros 2.7 billion, further expected to double by 2015 to Euros 5.5 billion (Diener and Piller, 2013).

Under the influence of competitive pressures from such a fast-growing market, intermediaries clearly need to continuously manage their business models, and make appropriate changes to it whenever required.

II.2.1.2. Internal Functioning

Intermediaries provide their services in the form of “packaged” innovation search services. They do this by applying pertinent technological infrastructure on one hand, while accessing a community of Solution Providers –scientists and experts from industry, academia, and research institutes from around the world (Roijackers et al., 2014) to provide solutions to companies seeking innovations.

The prevalent high level two-sided market model in the open innovation marketplace is one whereby innovation seekers – large or small organizations with a technical need – intend to solve their technical problem by leveraging the Solution Provider network of the intermediary. The intermediaries will support the production of the technical brief (also referred to as „needs statement“), and then initiate an open broadcast search, often identifying and encouraging solution providers to submit a solution proposal. Solution Providers screen the problem on the basis of their own technical expertise and knowledge areas, and respond only when they believe they can provide a suitable solution to the seeker’s problem. The proposed solution(s) reach the innovation seeker through the intermediary, and the innovation seeker then screens, evaluates, and finally selects the best solution(s), for further directed research and utilization. This entire process is facilitated by the intermediary, that drives forward each and every step – from need articulation, to problem broadcast, filtering and mapping of solutions, to final negotiations, deal making, and IP management (Roijackers et al., 2014). Figure II.2 shows the different functions in a graphical form.

Literature on internal functioning of open innovation intermediaries has so far been limited to discussing aspects such as the different roles and functions of the intermediaries (Howells, 2006); ways to bring in external knowledge by harnessing the power of intermediary networks (Billington and Davidson, 2012); or the role of intermediaries as architects in the form of co-creators and enablers of collective knowledge creation (Agogue et al., 2013).

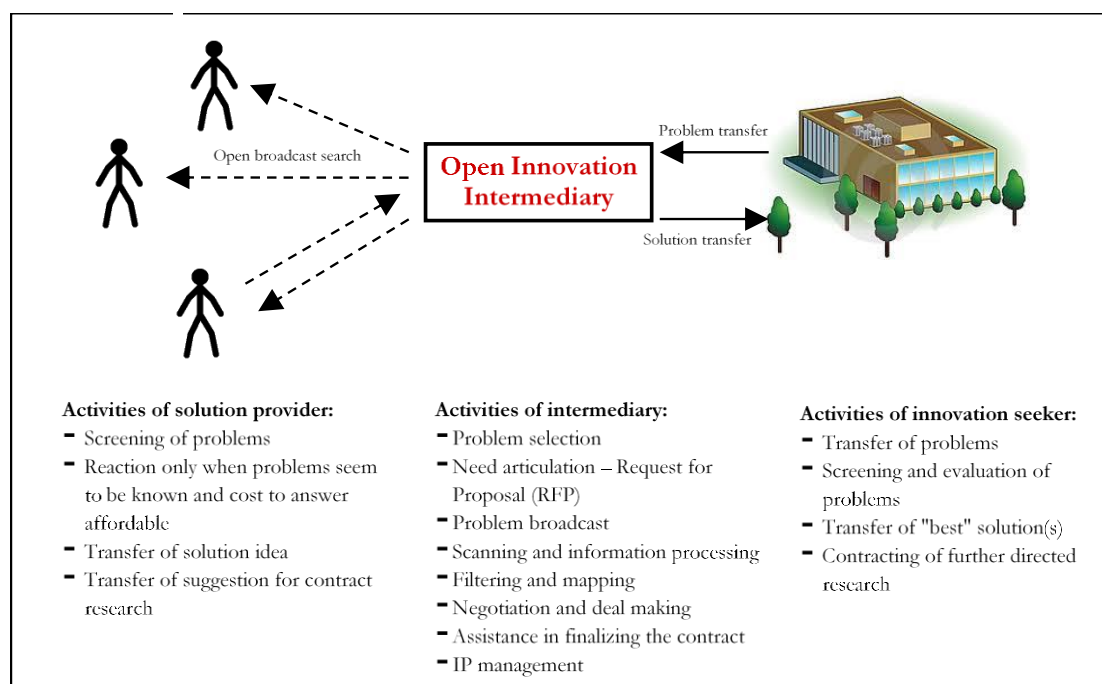


Figure II.2. Open innovation process flow (adapted from Piller, 2010).

However, it is clear that the intermediary internal functioning is still very much a “black box” in the literature, and this article will open said box.

II.2.2. Two Sided Market Model

An intermediary is basically a service firm that connects a network of innovation seekers to a network of Solution Providers. Thus, intermediaries operate under the framework of two-sided markets (Rochet and Tirole, 2003). Two-sided intermediary markets are driven by “indirect network effects”: the probability of arriving at a worthwhile technical solution by the innovation seeker (and thereby achieving Search Success) increases with the number (and quality) of Solution Providers that respond to the call for solution proposal (Kouris and Kleer, 2012). Hence, it becomes imperative for the intermediary to build a robust network on both sides of its market. The key challenge for the intermediary operating in a two-sided market is that it must win both customer sides to do business (Kouris and Kleer, 2012). An intermediary with a broad base of reputable clients will be respected by the Solution Provider community, and calls for proposals from such intermediaries will be taken more seriously, and vice versa. We will use two-sided markets as the reference model for our studies in this paper and assess the impact of business model changes on all three elements involved in this two-sided market - Innovation Seeker, Solution Provider, and the Intermediary.

II.2.2.1. Decision Parameters

a. Pricing: Rapid adoption of open innovation by companies worldwide (Billington and Davidson, 2012) has led to intermediaries constantly evolving their business model with respect to pricing strategy. With the number of new entrants on the rise, the pressure to keep improving is all the more intense. There are examples of previously well-performing intermediaries that have either gone out of business, or are in serious trouble, likely because they did not adapt a better business model fast enough, or just used the wrong business model from the start (iNewsWire, 2012; BusinessWire, 2012;). An example of using a very difficult business model is the use of the "success fee only" model that many new entrants take up. This model requires the client to pay only when a successful deal is made, and is essentially risk-free to the client. So the clients gladly try it, but the intermediary runs out of money fast. These instances suggest the need for intermediaries to keep revisiting and evolving their business model. As quoted by Johnson et al. (2008), "one secret to maintaining a thriving business is recognizing when it needs a fundamental change". Several such examples of companies being forced to redesign or extend their business model exist in literature and practice, outside the open innovation arena. Take, for instance, Ryanair, an Irish airline that switched in the early 1990s from a traditional airline to a low-cost one, in the face of stiff competition. Ryanair redesigned its business model by eliminating all frills, cutting costs, and slashing fares to all-time low (Casadesus and Ricart, 2011). The result has been a business model that enables Ryanair to offer a decent level of service at a low cost without radically lowering customers' willingness to pay for its tickets (Casadesus and Ricart, 2011). Another example is power-tool maker Hilti that switched from selling to renting its tools to construction contractors. The main motivation behind this change in business model was the entry of low-end competitors that made "good-enough" tools at much lower prices, thereby chipping away at the market for high-quality tools (Johnson et al., 2008). In a similar manner, open innovation intermediaries also evolve their business models from time to time.

b. Service Quality: Literature on two-sided market models focuses mainly on the analysis of pricing for both market sides while little has been reported so far on the impact of service innovation on both market sides of an intermediary. Lopez and Vanhaverbeke (2009) discuss business models of some innovation intermediaries and how they create and capture value in two-sided technology markets. The steps currently followed by NineSigma in their innovation process are detailed, and their strengths are discussed (Lopez and Vanhaverbeke, 2009). There are a few conceptual studies available in literature that provide brief analyses of the workings of innovation intermediaries such as InnoCentive, YourEncore, and InnovationXchange (Allio, 2004; Abbate

and Coppelino, 2011; Hakanson et al., 2012). Sawhney et al. (2003) touch upon the evolution of InnoCentive from a simple internet-based platform into an innovation marketplace, but not much is discussed on how the various service elements of InnoCentive might have evolved, and how that has possibly helped in improving Search Success. Thus, although we could find a few discrete references to the current business models of some prominent innovation marketplace intermediaries such as NineSigma, InnoCentive, YourEncore, and IdeaXchange, there are no reports available on how these intermediaries have evolved their two-sided service archetypes since their inception, and the impact this has had on the different dimensions of success in the context of open innovation intermediaries.

III.3. NineSigma – The Case

NineSigma is one intermediary that has been active in the open innovation market for more than a decade. Founded by Prof. Dr. Mehran Mehregany in 2000, NineSigma addresses technological challenges through internet-enabled global open broadcast searches and connectivity. NineSigma was founded on the premise that industry needed an effective means for broadcasting corporate technical needs to potential Solution Providers to stay ahead of the technology curve, similar to the methods employed by the U.S. Government research group, DARPA. NineSigma has an open innovation network of more than 2 million Solution Providers, and has done in excess of 2500 technology searches so far. NineSigma created a technology search process that has been continuously evolving over the years, by gaining practical insights from Search Successes and failures observed, as well as the impact this had on Intermediary Economics.

At the onset, only basic intermediation services were provided (Figure II.3):

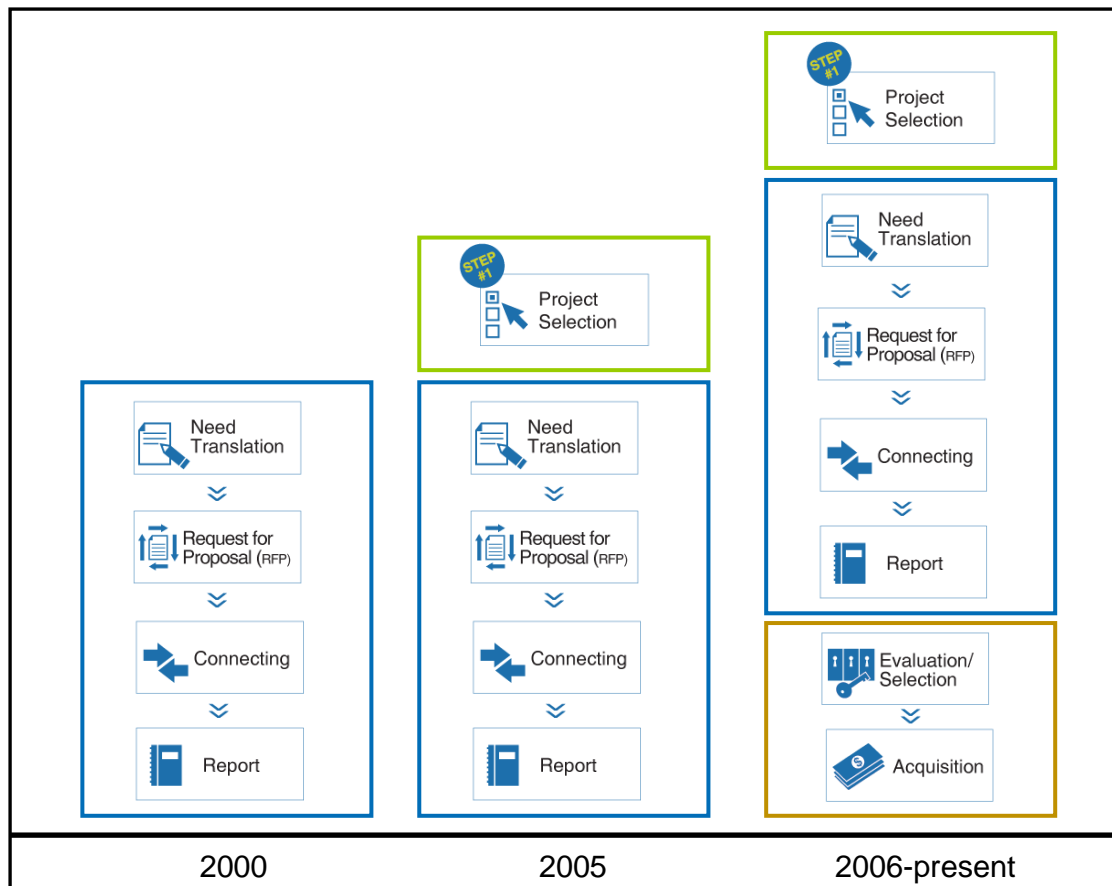


Figure II.3. Evolution of the technology search process at NineSigma from early 2000 to the present.

- Translating a needs statement and reducing it to its most basic science. This is needed for two reasons: a) it allows NineSigma to “cast a wide net”, i.e. looking for solutions proposals outside of the client industry and b) it allows NineSigma and the client to produce a needs statement that is non-confidential since application information and industry specific jargons are usually removed. For example, a client was looking for a solution to reduce wrinkles in shirts after they come out of the dryer. After several iterations NineSigma reduced this statement to “reducing surface tension of organic fibers”, and found a solution from a researcher in integrated circuits, who had developed a polymer for his research that did exactly what the client was looking for. What’s more, due to the cognitive bias of “The curse of knowledge” many Open Innovation practitioners have a difficult time expressing their need statement in a clear, compelling, and concise way (Zynga, 2013). Helping clients overcome this cognitive bias is one of the core competences of NineSigma.
- Finding potential Solution Providers across many different industries from around the world with solutions. This is another core competency of NineSigma, overcoming the

“local search bias” (Piller, 2010) that many practitioners of Open Innovation have a difficult time with. According to Luettgens et al. (2012), broadcasting a technical problem as widely as possible, among a heterogeneous network of external experts, allows even unknown outsiders from distinctly different scientific and technical backgrounds to contribute to its solution.

- Collecting, filtering and handing proposals to clients. NineSigma would review all incoming proposals in order to make sure they were complete, and did not contain any confidential information, and collate the solution proposals in the form of a customized client report.

This basic three step process archetype worked well until project data showed that for some large clients that ran a lot of projects with NineSigma (more than 50) over at least 3 years, Search Success declined significantly. This forced a review of both sides of the market model and an adjustment in both the service process and the fee structure.

II.4. Research Approach and Data

II.4.1. Approach

In the following chapters we will show how pricing, as well as particular service quality adjustments can impact overall success on all sides of the market. We will start by analyzing the “conventional” business model evolution with respect to pricing models and then focus on evolution of service archetypes in order to demonstrate the importance of this aspect of the intermediary model.

We’ve based the description of the original archetype on an interview with NineSigma’s founder (Professor Mehran Mehregany). The determination of changes to the archetype over time and the selection of client impact was done based on two inputs: Interviews with Service staff that has been with NineSigma since the inception of the business, and on a review of the database. Specifically, we reviewed data for clients that have performed more than 50 technology searches with NineSigma over a time frame of at least 3 years in a row in order to obtain a sound data foundation. We performed the analysis against the background of the two-sided market model in order to structure the findings in accordance with the theoretical framework of this paper.

Finally, we will answer the research question posted here based on the findings against the background of the body of literature dealing with two sided market models and open innovation intermediaries.

In order to answer this research question we designed a qualitative research approach since this allowed us to gain good access to NineSigma's business model structure and process. However we also address quantitatively why and how certain service elements have evolved based on decisions made through learnings, and illustrate specific cases where these decisions have influenced the overall outcome of the technology search process on both networks (and market sides).

II.4.2. Data

NineSigma has done more than 3000 technology searches since 2000, and there are many pertinent insights NineSigma gained from Search Successes and failures.

NineSigma owns a database with records on technology searches that include client names, dates, success rates and many other pertinent data. For this study, the following data were extracted and analyzed for this paper:

Data on technology searches performed for a particular client, date of search closed, and deal closed with Solution Provider; insights thus gained form the primary basis for this study. The different data sources, their use and results are listed in Table II.1:

Table II.1. Basis for data extraction and analysis for this study

Data Source	How Used	Results
Project Data (from database)	Extract deal rates for selected clients	Correlation between service changes and deal rates
Staff Interviews	Understand timing and extent of service changes	Correlation between service changes and deal rates
Staff Interviews	Determine which client examples to choose for review	Selected two major client cases
Internal Memos	Follow decision making on business model changes	Established decision timing
NineSigma P&L	Determine transaction fee revenues evolution	Understand timing of fee decline
Client communication documents	Determine basis for business model change decisions	Checked timing and impact of decisions on selected clients

II.5. Results

II.5.1. Overview

According to the founder of NineSigma the original business model was loosely modeled on the DARPA technology search archetype: A team of interdisciplinary Ph.D.'s would translate a specific technology need from a requesting party (at DARPA: Federal United States Agencies; at NineSigma: Clients; collectively: "Innovation Seekers") into a Request for Proposal (RFP), search for suitable Solution Providers across different industries, and then provide solution proposal packages to the Innovation Seekers.

This archetype represents a two-sided market model, with Innovation Seekers on one side, and Solution Providers on the other side. Two-sided market theory suggests that pricing is a key factor for such markets, and is more complex in two-sided markets than in traditional businesses. Decisions on pricing strategy for two-sided markets need to consider the interaction between the two market sides, and willingness of each side to pay (Eisenmann et al., 2006). Kouris and Kleer (2012) point out that while deciding on a pricing strategy, two decisions need to be made: firstly, which side to subsidize, and secondly, what kind of fees to charge. The "subsidy side" is the group of users that, when attracted in volume, are highly valued by the "money side" (Eisenmann, 2006). The number of subsidy side users is crucial in developing strong network effects, and hence the platform provider encourages this group to grow through subsidization. In the context of intermediated OI, Solution Providers typically form the subsidy side, while Innovation Seekers are the money side, as we will see in more detail below.

II.5.2. Evolution of Pricing Model

The original pricing model was such that Innovation Seekers were paying a relatively low price per technology search project, but were obligated to pay a "Transaction Fee" to NineSigma that was a function of the dollar value of the eventual contract consummated between Innovation Seeker and Solution Provider. The idea was to attract more Innovation Seekers with a low entry price and suggest common interest in creating successful outcomes, with NineSigma having "skin in the game" in the sense of shared risk / reward.

There was also the option for the Innovation Seeker (the "money side") to pay a flat fee per project with no transaction fee at the end. However, in that case the fee per project was

significantly (about 50%) higher than with the transaction fee model, and the NineSigma sales force was supposed to always lead the fee discussion with the transaction fee model.

The "subsidy side" of the market - Solution Providers - did not pay any fee at all. This was based on the need to create indirect network effects, i.e. to incentivize as many potential Solution Providers as possible to respond to NineSigma RFP's, and to quickly build the network of known Solution Providers.

An analysis of the trend in transaction fee volume over the years (Figure II.4) reveals a steady decline in transaction fee volume from 2009 onwards.

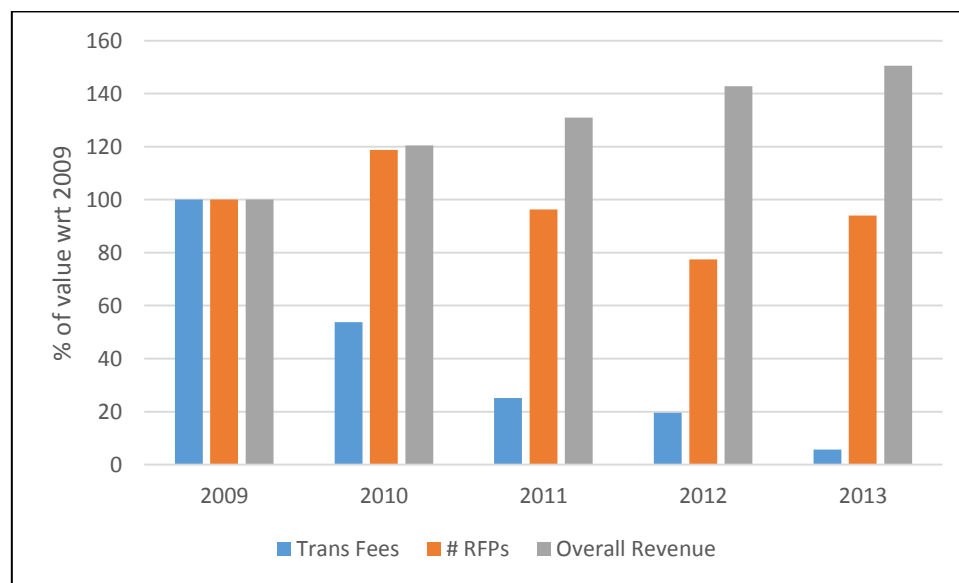


Figure II.4. Trend in transaction fee volume vs overall revenue.

The management team investigated the drop and learned that the sales force didn't like the transaction fee model since clients gave negative feedback to them about it:

- It made budgeting for project expenses difficult since the transaction fee amount was unknown at time of sales order
- The transaction fee was open ended and could lead to clients paying ad infinitum (this issue was usually handled in negotiations by capping)
- Sometimes different client departments were responsible for paying project fees vs transaction fees, which led to client internal conflict
- The fee as a percentage of deal volume was seen as too high (again, this was often reduced in fee negotiations with clients)

As a result, the sales force would often switch the discussion to the flat fee option very quickly and not use the transaction fee option. For NineSigma, while transaction fees had the potential to significantly boost the profitability of the business, especially if large deals were consummated, they also had the negative effect of reducing cash flow, since deals between Innovation Seekers and Solution Providers took months, and sometimes years, to be closed. Additionally, the average deal size was usually so small (on average about 10% of the project fee across all RFP's) that the higher project price was actually more lucrative overall to the business. Consequently, the management team decided in 2010 to change its pricing structure to better accommodate these issues, and phased out transaction fees altogether thus creating a "win-win" situation for both clients and NineSigma.

Overall RFP revenue went up since the number of RFP's published didn't drop significantly, and in fact have risen lately (see Figure II.4).

Lastly, Provider Success was impacted positively, since the willingness to "do deals" went up on the seeker side as shown above. What's more, the seeker side was less dis-incentivized to do larger deals since no sharing of the deal volume took place, and this might contribute positively to potential Provider Success.

In summary, all sides of the two sided business model, Seekers, Solution Providers, and intermediary were impacted positively by this pricing change.

II.5.3. Service Process Changes

Apart from the change in pricing structure as described above, there are examples wherein service elements were added to NineSigma's Technology Search Process to better address the needs of Innovations Seekers and Solution Providers, and thereby improve the quality of NineSigma's services:

- The introduction of a rigorous project selection step in the client engagement process that was driven by the need to improve success rates and improve the standing of "partner of choice" with Solution Providers for both the client and NineSigma
- The introduction of a back end support process whereby NineSigma facilitates the selection process once solution proposals from many sources have been found by NineSigma. This part of the process served to improve success rates with clients

These two examples are explored in more detail and their impact on the evolution of NineSigma's two-sided business model is shown below.

II.5.3.1. Project Selection

Based on interviews with NineSigma service delivery staff present since the beginning of the business, we selected the project data of one particular client that could serve as a proxy for showing the impact of a change in the variable of "change in the service process" archetype. This client had used NineSigma's services for 8 years and had run about 200 projects with NineSigma over that timeframe; thus we had a good amount of data available for our analysis. This client was an early adopter of open innovation.

Project data showed that though the deal close rates for this client were quite good in the early years, there was a sharp decline in deal close rates in the subsequent years (2003 onwards) (Table II.2).

Table II.2. Data on deal close rates for a long-term client of NineSigma

Year	Number of Projects	Number of Deals Closed	% Deals Closed
2001	2	1	50%
2002	22	11	50%
2003	26	6	23%
2004	33	4	12%
2005	45	4	9%

The NineSigma service delivery staff we interviewed reported that this client had had an internal team that had embraced the concept of open innovation, did very thorough project selection before passing on a project to NineSigma, and functioned as a "gatekeeper". These people were what is referred to in the business "process champions" (Roijsackers et al., 2014). Thus, following internal selection by the seeker, only the most suitable projects were handed to NineSigma. The NineSigma management team found out that in 2004, there was an internal reorganization within the client company, and the champions had moved to other positions. Project selection was no longer done to the rigorous standards. NineSigma hadn't been aware of those changes, and consequently continued to execute projects as submitted by the client. However, an obvious result was that the Search Success rates were dropping dramatically (see Table II.2 and Figure II.5). Upon realizing the reason for this drop in Search Success, NineSigma changed its service approach and started carrying out a rigorous project selection process.

Following the introduction of project selection, the number of projects that NineSigma handled for this client dropped from 45 in 2005 to 20 in 2006. However, the success rate in 2006 was much higher, with 15% of deals closed (this was 8% in 2005) (Figure II.5). Though Search Success rates with this particular client improved significantly, it never recovered to the initial levels due to a variety of factors, such as changing priorities, funding, and approach to open innovation projects (stronger focus on ideation as opposed to full solution seeking).



Figure II.5. Effect of introducing project selection step.

Furthermore, in other instances, NineSigma executives noticed that some clients were using the technology search service to “just see what’s out there”, and did not seem to be interested in making deals. This was a problem as that gave both the client and NineSigma a bad reputation with Solution Providers. Solution Providers form one side of the two-sided market of NineSigma’s business, and a bad reputation with Solution Providers could potentially impact the overall performance of NineSigma due to positive indirect network effects getting reduced. It was also noticed that some clients were pulling out “holy grail” projects – problems long known as highly relevant but complex and “unsolvable” to the entire industry – out of the drawer in order to challenge the job of the intermediary. Employees of some clients seemed to act opportunistically when the problem to broadcast was being selected, suggesting unrealistic tasks that were deemed “unsolvable”, but of relevance to everybody involved in it (Luettgens et al., 2012). This was the case especially when the management of the company decided to buy projects while the project teams then had to come up with project ideas. This is critical for the management of both sides of

the market since a significant drop in deals being made reduces Solution Provider's interest in submitting solutions. This in turn makes it less interesting for solutions seekers to work with NineSigma.

One example illustrating this case is an automotive OEM that engaged NineSigma for 10 projects, out of which 9 projects could not be successfully closed by a deal despite the availability of good solutions. The reason for this turned out to be that the technical needs broadcasted were not big enough to drive a good business opportunity. The VP of R&D was later quoted as follows: "... I would not have supported selection of those needs if I had known about them ahead of time".

In the meanwhile, in 2006, NineSigma Japan was established, and Japanese clients tended to require a written assessment of topics in the sense of probability of Search Success.

These developments led NineSigma to revisit its technology search process. NineSigma decided to critically assess the main factors that govern which project would be best suited for broadcasting, and came up with a set of criteria that need to be met for a project to be qualified as a good candidate for open broadcasting (Stupay and Uribe-Saucedo, 2008). The criteria are:

- A revenue or cost savings opportunity that is meaningful to the business and justifies investment. This is important in order to insure that the project has a significant reward for Solution Providers and thus creates positive indirect network effects. It will also serve to avoid shifting client priorities and associated risks of project 'defunding', thus ending a project without any outcome
- Technical or product hurdles that can be refined to a tactical or strategic need that can be sourced externally. For the search process to work optimally it is important to be able to distill the problem statement down to its most basic science as described above. If this

EXHIBIT II.1: Measuring success with open broadcast search

While this paper focuses on the "deal rates", i.e. the amount of contracts consummated between Innovation Seekers and Solution Providers, success with open broadcast search can be measured at various levels (see also Exhibit 2):

- o The proposal count that each Request for Proposal (RFP) receives; however, most clients are not interested in massive amounts of proposals since that means they need to spend valuable time reviewing them all
- o The count of "interesting" proposals received for each RFP. NineSigma filters the proposals and "green-lights" the interesting ones, to save the client some effort
- o A Non-Disclosure Agreement (NDA) was signed with a potential solution provider
- o Finally, a signed deal with the solution provider to transfer knowledge, or IP in the form of a license, or any other suitable agreement

isn't possible, then the project is not suitable for this process.

- A passionate project team with at least one dedicated person committed to success. The dedicated person is what we call a "champion" who drives the process forward and overcomes client internal hurdles. An Open Innovation champion is typically an experienced, high-profile individual who is well-connected within the innovating firm and is empowered to manage all phases of external knowledge searching (Roijakkers et al., 2014).
- A willingness to aggressively evaluate and acquire the new technology if a solution is found. This is a key ingredient for positive indirect network effects, with Solution Providers being more motivated to submit proposals and to sign up for more technology searches if they feel they have a real chance to successfully close business with a NineSigma client.

Subsequently, NineSigma systemically implemented the project selection step to its technology search process (refer Figure II.5). This led to fewer, but more worthwhile projects being done and more successes created, thereby improving the reputation of NineSigma's services among seekers and Solution Providers alike. One data set that is a good proxy for this is

EXHIBIT II.2: Defining success from seeker's perspective

As shown in Exhibit 1, success can be defined in more ways than just the deal closure rates. Success can have different meaning for different clients. Here are a few quotes from NineSigma clients that were collected in the course of an interview series for a research project that validate this:

- "For me a successful project is the one that ends in a signed agreement for further cooperation, the ones that only give me information are not successful"
- "Some challenges may be expected to receive a wide range of solutions...specific narrow projects may be considered as successful when they provide key and insightful contributions"
- "...we didn't discover anything new. That may be a failure for some but for us it validated what we already know. So, we moved into something else and we don't spend any more money on that matter..."
- "One of the problems is that people who are judging say what's the success rate and I reply what's the success rate of an experiment. For me, 40% is enormous. If you work in that way, it doesn't bother you but if not, then you have a problem. People think that because you bought an RFP, you should have solution. No. I bought an RFP to do something and that's a

the average number of solution proposals submitted by Solution Providers, which went up from 8 in 2005 to 20 in 2009 (see Figure II.6).

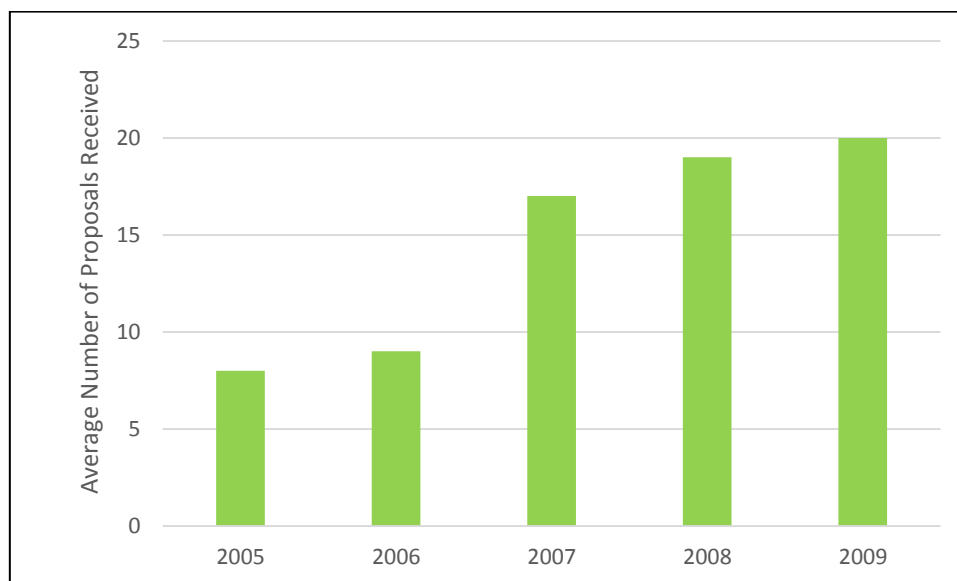


Figure II.6. Increase in the average number of solution proposals received following introduction of the project selection step in 2005.

This is an example of market pressures leading to adjustment on one side of the two-sided market model at NineSigma: The need to reduce the number of projects done with innovation seekers in favor of picking projects that have the highest probability of Search Success. All else being equal, it also demonstrates the effect on deal closure rates that service model adjustment can have on the interactions of both sides of the two-sided market model. Clearly this is one of the key functions of a platform provider such as NineSigma.

II.5.3.2. Solution Provider Evaluation Support

For the first 6 years the NineSigma process archetype was such that the process would end with the report on solution proposals received being presented and discussed with clients. However, as the average number of solution proposals received increased, as shown in the previous section (there are cases when the number of proposals received reached 100), clients began to feed back to NineSigma service staff that they were looking to NineSigma to structure the information more systematically. What’s more, NineSigma program managers learned that selecting the suitable solution proposals was a process that often led to delays due to client internal stakeholders being brought in too late, or not at all. For example, the most technically sound solution might not be the right one for a company if the material involved is available from only one source in the

world, and if the risk policy of this client is to never engage with single source only. This situation was discussed in the NineSigma management team and it was decided to add a process step that includes managing the selection process, as well as producing a technology map that highlights the proposals received in a more systematic way.

Additionally, NineSigma management decided to hire an external consultant that was tasked to create a comprehensive "back end" process based on interviews with service delivery staff, sales staff, NineSigma management, and NineSigma clients. The result of this was that in 2006 NineSigma changed the service archetype on both sides of the market, and rolled out the service on Solution Provider Evaluation Support – internally called "SuccessMAP" (MAP being Method to Assess Providers). A three-step process has been developed and is consistently followed (Figure II.7):

Stage 1: Rank

- Proposals are evaluated for their relative fit to criteria laid down for each RFP
- Solution Providers are ranked by their level of interest

Stage 2: Assess

- Non-confidential and confidential information is gathered
- Sampling and interviewing done to attain a clearer picture on the Solution Provider and the solution

Stage 3: Acquire

- Deliverables are clearly defined and communicated
- Agreement developed and negotiated

Concerning the questions that need to be answered for solution proposals, the consultant summarized findings as follows:

- Does the solution abstract meet the stated requirements of the RFP?
- Does the abstract contain sufficient information about IP status, commercial intentions of the proposer?
- Does the abstract make a credible case for technical success?

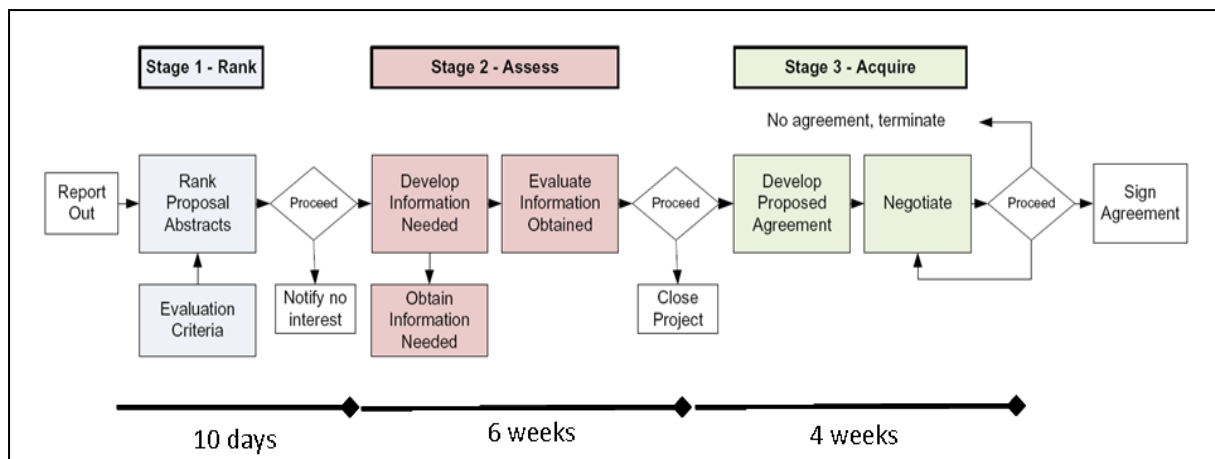


Figure II.7. Process flowchart for solution provider evaluation support at NineSigma.

NineSigma also engages with the Solution Provider in follow-up communications by means of emails, phone calls, and teleconferences. This is done in order to protect the client's anonymity, if that is required for the project. On average, 80% of NineSigma technology searches are done for clients that wish to remain anonymous.

The Solution Provider Evaluation Support service serves to:

- Help clients prioritize the proposed solutions. This is done in order to speed up the review process for client, as that is one of the points that was fed back by clients to program managers as the amount of proposals per RFP increased
- Help clients establish agenda questions to be discussed with candidate Solution Providers. This is done in order to create a conversation that still remains in the non-confidential space, and that best corresponds to the priorities established
- Schedule phone calls between clients and Solution Providers. This helps to maintain anonymity for the NineSigma client
- Facilitate the information exchange, which includes all client internal stakeholders and their respective constraints
- Track participation

NineSigma makes use of a traffic light system to recommend and prioritize solution proposals meeting clients' original objectives where 'green lighted' solutions represent the most valuable solutions in terms of meeting technical specifications.

A few client testimonials confirm the effectiveness of the Solution Provider Evaluation Support service: "... NineSigma ranks solutions based on relevant criteria that allow us to prioritize the top responses..."; "... it is not just about the number of solutions we receive... it is about the number of solutions we find useful..."

The change of the NineSigma process archetype is a clear example of adjustment of service quality on all sides of the market:

- On the client network side, a much more detailed and stringent facilitation process is followed. This leads to faster transactions between seekers and solution providers, which benefits both sides
- On the Solution Provider side, a more frequent interaction and communication is implemented, which increases Solution Provider satisfaction, and thus a higher willingness to repeatedly submit solution proposals
- As far as Intermediary Success is concerned, the faster process to deal closure led to higher client (seeker) satisfaction, and thus more repeat searches, i.e. clients coming back for more

This adjustment was done due to market pressures, namely clients feeding back information to program managers, who in turn discussed this with the management team. It is evidence of a maturing of the market in the sense of positive indirect network effects increasing and creating new pressures for changing the business model.

The question of whether or not this change has an influence on the Search Success rates is of scientific interest. In order to answer this question we again interviewed service delivery staff and reviewed project and client data. The interviews revealed that there is one particular client from the automotive industry, which had run more than 50 projects over at least 3 years, with whom the new service process was piloted. The reason was that this client was the most vocal about the need to enhance the service model and add support at the "back end" of the process. This client was very interested in being the initiator of this new model. This client had been experiencing a decrease in deal close rates, and was looking to receive support from NineSigma to find a solution to this problem. In 2006, the Solution Provider Evaluation Support program was piloted with this client.

As can be seen in Table II.3 and Figure II.8, an earlier drop in the deal close rates was alleviated following the introduction of Solution Provider Evaluation Support into the technology search process for this large automotive company.

Table II.3. Data on deal close rates for an automotive client of NineSigma.

Year	Number of Projects	Number of Deals Closed	% Deals Closed
2005	13	3	23%
2006	17	1	6%
2007	29	4	14%
2009	6	1	17%
2011	10	3	30%

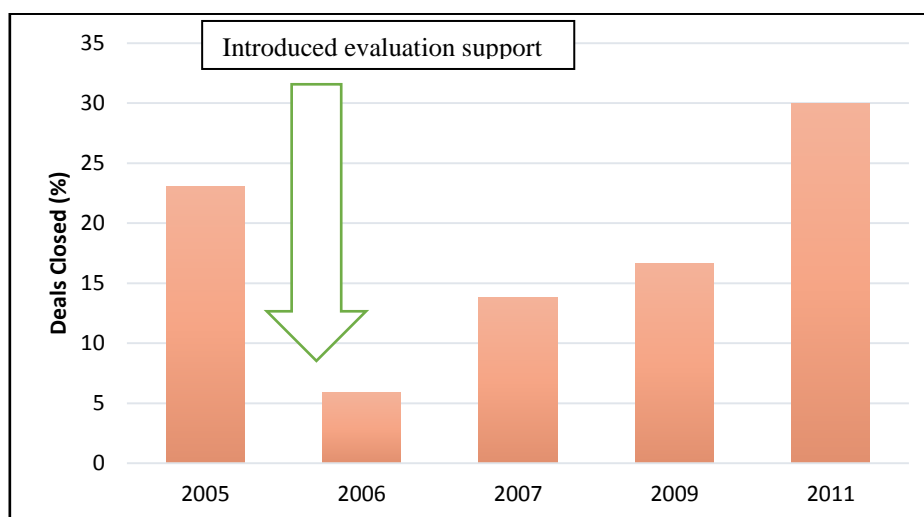


Figure II.8. Effect of introducing solution provider evaluation support on project success.

This is an example of the service delivery team in conjunction with NineSigma management deciding to change the service delivery archetype for a particular client based on market pressures: one particularly important client (the automotive client described here) as well as several smaller ones voiced the need for service enhancement. The management team then brought in a consultant to enhance the service archetype. A pilot client was identified and the new model applied. This client's deal closure rates went up significantly since the introduction of the new model. Interviews with service delivery staff indicated that no other factors were changed at this client, so it can be argued that the change of service model had at least some influence on the improvement of deal rates. The question of correlation between service model adjustment at the intermediary and the client success can thus be answered positively.

These results show that both price model adjustment as well as service archetype adjustment have an influence on all three success dimensions of the two sided market model, as well as Search Success. Every time a measure was taken, NineSigma needed to adjust both sides of the market model in order to address positive indirect network effects and that actually created more effort for NineSigma clients (increased amounts of proposals; need to involve more stakeholders internal to client).

II.6. Discussion of Results

The main objective of this paper was to show that research on two-sided business models needs to go beyond a mere analysis of pricing models. To that end, we analyzed open innovation intermediary NineSigma, which is a company operating a platform model with two market or network sides: Innovation Seekers and Solution Providers.

We showed that market pressures lead to the need to continuously evolve the business model with respect to pricing. Specifically, in the beginning stages of market development, relatively low project prices on the seeker side only along with a transaction fee in case of deal closure (i.e. a success fee) was sufficient to build both sides of the market. However, as the market matured and pressures were building both from the side of the early adopter customer base, as well as the competition, raising the project fee in favor of dropping the transaction fee altogether led to more growth and client satisfaction. This largely confirms existing literature on two-sided markets.

However, this is also a surprising result as the expectation would have been for market based approaches to prevail over fixed fee models (Armstrong, 2006). In other words, an entrepreneurial stance of buyers would be to go for lower fixed fees and higher variable ones with a view to sharing in successful outcomes.

Anecdotal evidence from practice at NineSigma points to the fact that buyers at large corporate organizations – the primary client base of NineSigma – are more concerned with predictable budget allocations for projects vs the variable “shared risk / shared reward” approach. The incremental benefit of fixed cost pricing seems to outweigh the incremental benefit of potentially lower and pertinent variable project fees.

Market pressures also led to the need to change the service process archetype, which had an impact both on the economic success of NineSigma, as well as the client network and the solution provider network through improved deal closure rates and client satisfaction.

This is where existing literature today assumes that "service quality" in two sided markets is a given and as such static. One might argue that service quality adjustments might be reflected in the price component as well, if prices are adjusted to include changed or improved service quality. However, during the time frame under review in this paper fees for technology searches hardly changed, and were adjusted upwards after that time window based on market opportunities, not based on cost considerations.

When reviewing the impact of service quality changes shown in this paper it appears that the introduction of the project selection step had a lesser impact on the deal rates than the introduction of the evaluation support. However, as mentioned above, the recovery of deal rates in the first example are heavily influenced by organizational changes at the client, so that the quantification of service quality changes cannot be done, at least not in the examples we reviewed.

One needs to ask if studies on other intermediaries should have included the aspect of service quality adjustments as well. In other words: the evolution of the service archetype including service quality need to be tested at a minimum when analyzing Open Innovation intermediaries. Consequently, we suggest that future studies on the success of intermediated open innovation service include a review of the intermediary internal service in order to assess the impact such changes may have had on the project data reviewed by such studies. This is particularly important in the case of review of long term data (i.e. over a time frame of 2-3 years or more)

Existing literature suggests that indirect network effects are given when potential Solution Providers are getting increasingly interested in providing solutions when the network of innovation seekers is large (Eisenmann et al., 2006; Kouris and Kleer, 2012).

However, we showed that improved service quality has an indirect network effect as well. When NineSigma changed its service archetype to include more care for and many more touch points with Solution Providers it led to more proposals being submitted by Solution Providers. Increasing amounts of proposals in turn led to clients wishing an adjustment of the service process archetype in order to be able to absorb all of the proposals, which also led to accelerated evaluation processes and thus higher deal rates.

Other factors, such as increased brand recognition may have played a role in the rising amounts of proposals being submitted over the years, but NineSigma was never alone in its access to the pool of Intermediaries as we showed above, so that the significant increase in the amount of submission is most likely based on the changes in the service quality.

This paper provides insights into the working of an intermediary business, and innovations taking place in their business model. The examples examined are from over 5 years ago, so that the question might be about further, more recent changes. While there have been many more changes, the examples provided are representative for the purpose of this paper, and the provision of more recent developments carry competitive risks to NineSigma. Therefore, this paper identifies that in reports on success with open innovation involving intermediaries, the focus has always remained on either the innovating company, or the Solution Provider, whereas the functioning of the intermediary has always been taken as a static element. The paper points out that the functioning of the intermediary – an important link in the open innovation process – is dynamic, and is continuously evolving, so as to improve success rates of its clients' open innovation endeavors. .

Table II.4 provides a summary of the different measures taken by NineSigma with respect to the business model and the impact it had on both sides of the market, and NineSigma itself.

Table II.4. Impact of business model change on NineSigma and its market sides.

Business Model Change	Impact on Seeker Side	Impact on Solution Provider Side	Impact on NineSigma
Elimination of Transaction Fee	<ul style="list-style-type: none"> • Easier budgeting of projects due to fixed price • More new clients 	<ul style="list-style-type: none"> • More interest in submitting due to higher possible asking prices (no additional fees) • More Solution Providers due to more clients 	<ul style="list-style-type: none"> • Better cash flow due to higher fees early on • Higher overall fees per RFP • More revenue overall due to more clients
Introduction of Project Selection	<ul style="list-style-type: none"> • Fewer projects overall, but more fully funded RFPs 	<ul style="list-style-type: none"> • Higher close rates increase interest in submitting, and more Solution Providers will sign up 	<ul style="list-style-type: none"> • Better credibility with clients leads to higher client satisfaction and repeat clients
Introduction of Solution Provider Evaluation Support	<ul style="list-style-type: none"> • Faster process leads to higher client satisfaction/repeat clients • NineSigma value addition more visible 	<ul style="list-style-type: none"> • Faster process leads to higher satisfaction • More touch points with NineSigma, better understanding of value, better reputation, more Solution Providers signing up 	<ul style="list-style-type: none"> • More deals closed, more repeat clients, more revenues • Higher fees per RFP, more revenue

II.7. Limitations and Further Research

Since this paper considers the experience of only one open innovation intermediary – NineSigma, there are some limitations to the conclusions that can be drawn from this study. Experiences with other intermediaries may be different, and hence the findings of this study cannot be easily generalized with other empirical settings. Instead, this paper aims to provide indications of how the business model of an open innovation intermediary evolves over time owing to pressure from both sides of the market – the seeker side and the solution provider side. Our results offer a foundation for extension of the theory that service quality is critical to success with technology searches and they have a significant impact on both sides of the business model. More research in this direction is needed, ideally by looking at more companies that operate in this kind of two-sided market, especially open innovation intermediaries. It would be worthwhile to understand how the business model of other open innovation intermediaries might have evolved, and how this evolution might have affected their performance.

Another limitation is that the quantitative perspective of this study focused on only two clients that had run more than 50 projects with NineSigma. These clients, because of the number of projects they did with NineSigma, provide a good representative sample, but a more extensive analysis of a larger number of clients, and direct interviews with these clients, could have revealed more factors that may have had an influence on the overall success of the technology search process.

In the present study, our focus has been on one form of open innovation – open broadcast search. Perhaps a good subject for future research could be to study whether the observations from this study can be transferred to other forms of open innovation that NineSigma offers, such as technology landscaping. Despite these limitations, we believe that our study makes two important contributions to the two-sided market theory pertaining to open innovation intermediaries: 1. Establishes the importance of reviewing internal service of an intermediary, when studying Search Success of intermediated open innovation, and 2. Offers an extension to the two-sided market theory, beyond the pricing model, and highlights a previously untouched area – that service quality is an important variable impacting the performance of the platform provider in a two-sided market.

II. References

- Abbate, T., & Coppelino, R. (2011). Knowledge creation through knowledge brokers: some anecdotal evidence. *Journal of Management Control*, 22(3), 359-371.
- Abbate, T., Coppelino, R., & Schiavone, F. (2013). Linking Entities in Knowledge Transfer: The Innovation Intermediaries. *Journal of the Knowledge Economy*, 4(3), 233-243.
- Agogu , M., Ystr m, A., & Le Masson, P. (2013). Rethinking the role of intermediaries as an architect of collective exploration and creation of knowledge in open innovation. *International Journal of Innovation Management*, 17(2), 1-31.
- Allio, R. J. (2004). CEO interview: the InnoCentive model of open innovation. *Strategy & Leadership*, 32(4), 4-9.
- Antikainen, M. (2011). *Facilitating customer involvement in collaborative online innovation communities*. Ph.D. Thesis. Tampere University of Technology, Tampere, Finland, VTT Publications 760.
- Armstrong, M. (2006). Competition in two-sided markets. *The RAND Journal of Economics*, 37(3), 668-691
- Arora, A., Fosfuri, A., & Gambardella, A. (2001). Markets for technology and their implications for corporate strategy. *Industrial and Corporate Change*, 10(2), 419-451.
- Barrett, C., Musso, C., & Padhi, A. (2010). *R&D after the crisis*. McKinsey Global Survey Report. McKinsey and Company.
- Bellairs, J. (2013). Presentation at the Institute for Food Technologists Annual Meeting and Food Expo, July 13-16, Chicago, Illinois, USA.
- Billington, C., & Davidson, R. (2013). Leveraging open innovation using intermediary networks. *Production and Operations Management*, 22(6), 1464-1477.
- Boudreau, K. J. & Lakhani K. R. (2009). How to manage outside innovation. *MIT Sloan Management Review*, 50, 69-76.
- Brunswick, S., & Hutschek, U. (2010). Crossing horizons: leveraging cross-industry innovation search in the front-end of the innovation process. *International Journal of Innovation Management*, 14(04), 683-702.
- Brunswick, S., & Vanhaverbeke, W. (2011). Beyond open innovation in large enterprises: How do small and medium-sized enterprises (SMEs) open up to external innovation sources? Available at SSRN: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1925185
- BusinessWire. (2012). <http://www.businesswire.com/news/home/20121205006638/en/Innovaro-Receives-Delisting-Notification-NYSE-MKT#.UtysshC6bIU>. December 05.
- Capozzi, M.M., Gregg, B., Howe, A. (2010). *Innovation and commercialization*. McKinsey Global Survey Report. McKinsey and Company.
- Casadesus-Masanell, R., & Ricart, J. E. (2011). How to design a winning business model. *Harvard Business Review*, 89(1/2), 100-107.

- Che, Y.K., & Gale, I. (2003). Optimal design of research contests. *American Economic Review*, 93: 646-671.
- Chesbrough, H.W. (2003). A better way to innovate. *Harvard Business Review*, 81(7), 12-3.
- Chesbrough, H.W. (2003a) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.
- Chesbrough, H. W. (2003b). The era of open innovation. *MIT Sloan Management Review*, 44(3), 35.
- Diener, K., & Piller, F. (2010). *The Market for Open Innovation*. Raleigh, NC: Lulu.
- Diener, K., & Piller, F. (2013). *The Market for Open Innovation*, (2nd ed.). Raleigh, Lulu.
- Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Management*, 36(3), 333-346.
- Dushnitsky, G., & Klueter, T. (2011). Is there an eBay for ideas? Insight from online knowledge marketplaces. *European Management Review*, 8, 17-32.
- Eisenmann, T., Parker, G., & Van Alstyne, M. W. (2006). Strategies for two-sided markets. *Harvard Business Review*, 84(10), 92.
- Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: exploring the phenomenon. *R&D Management*, 39, 311-316.
- Erickson, P. (2008). One food company's foray into open innovation. *PDMA Visions Magazine*, NPD Trends/Practices, June, 13-14.
- Håkanson, L., Caessens, P., & MacAulay, S. (2011). InnovationXchange: A case study in innovation intermediation. *Innovation*, 13(2), 261-274.
- Howells, J. (2006). Intermediation and the Role of Intermediaries in Innovation. *Research Policy* 35(5), 715-728.
- Huston, L., & Sakkab, N. (2006). P&G's new innovation model. *Harvard Business Review*, 84, 58-66.
- iNewsWire. (2012). <http://www.i-newswire.com/inventorhaus-inc-acquires-ideawicket/175648>. May 15.
- Jeppesen, L. B. & Lakhani, K. R. (2010). Marginality and Problem-Solving Effectiveness in Broadcast Search. *Organization Science*, 21(5), 1016-1033.
- Johnson, M. W., Christensen, C. M., & Kagermann, H. (2008). Reinventing your business model. *Harvard Business Review*, 86(12), 57-68.
- Katzy, B., Turgut, E., Holzmann, T., & Sailer, K. (2013). Innovation intermediaries: a process view on open innovation coordination. *Technology Analysis & Strategic Management*, 25(3), 295-309.
- Kilelu, C.W., Klerkx, L., Leeuwis, C., Hall, A. (2011). Beyond knowledge brokerage: an exploratory study of innovation intermediaries in an evolving smallholder agricultural system in Kenya. Research into Use, Discussion Paper 13.

- Klerkx, L., & Leeuwis, C. (2008). Balancing multiple interests: Embedding innovation intermediation in the agricultural knowledge infrastructure. *Technovation*, 28(6), 364-378.
- Kouris, I., & Kleer, R. (2012). Business models in two-sided markets: an assessment of strategies for app platforms. International Conference on Mobile Business. Paper 22. <http://aisel.aisnet.org/icmb2012/22>. 2012
- Lakhani K.R., Jeppesen, L.B., Lohse, P.A., & Panetta, J.A. (2006). The value of openness in scientific problem solving. HBS Working Paper Number: 07-050, Harvard Business School.
- Laursen. K., & Salter. A. 2006. Open for Innovation: The Role of Openness in Explaining Innovation Performance among UK Manufacturing Firms. *Strategic Management Journal*, 27, 131-150.
- Lichtenthaler, U., & Ernst, H. (2008). Intermediary services in the markets for technology: Organizational antecedents and performance consequences. *Organization Studies*, 29, 1003-1035.
- Lichtenthaler, U. (2011). Open Innovation: Past Research, Current Debates, and Future Directions. *The Academy of Management Review*, 25(1), 75-93.
- Lopez, H., & Vanhaverbeke, W. (2009). How innovation intermediaries are shaping the technology market? An analysis of their business model. (No. 20458). University Library of Munich, Germany.
- Luetgens, D., Antons, D., Pollock, P., & Piller, F. (2012). Implementing open innovation beyond the pilot stage: barriers and organizational interventions. RWTH-TIM Working Paper, October.
- Mortara, L. (2010). *Getting help with open innovation*. University of Cambridge Press, Cambridge.
- Philips Annual Report. (2007). Domestic Appliance & Personal Care Division (DAP), 2007 financial performance, p. 74.
- Philips Annual Report. (2006). Domestic Appliance & Personal Care Division (DAP), Strategy & 2007 Objectives, p. 65.
- Piller, F.T. (2010). From technology market places to problem places. Keynote presentation at Quebec Seeks Solutions. Quebec City, Canada, December 14.
- Piller, F.T. (2011). Open innovation readiness: creating a culture and organization to profit from open innovation and customer co-creation. Downloaded from http://openinnovation.berkeley.edu/Frank_Piller_2_7_2011.pdf
- Roijakker, N., Zynga, A., & Bishop, C. (2013). Getting help from innomediaries – what can innovators do to increase value in external knowledge searches? Book chapter in “*Exploring the next wave of open innovation research*” by Chesbrough, H., West, J., Vanhaverbeke, W. (Eds.) Oxford University Press.
- Sawhney, M., Prandelli, E., & Verona, G. (2002). The power of innomediation. *MIT Sloan Management Review*, 44(2), 77-82.
- Sieg, J. H., Wallin, M. W., & Von Krogh, G. (2010). Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. *R&D Management*, 40(3), 281-291.

Stupay, P., Uribe-Saucedo, S. (2008). Open innovation and the value of non-confidential exchange: A NineSigma customer insight paper on Kellogg's.

Zynga, A. (2013). The innovator who knew too much. HBR Blog Network. <http://blogs.hbr.org/2013/04/the-innovator-who-knew-too-muc/> April 29.

Research Paper III:

Successful and Sustainable Implementation of Open Innovation: An Empirical Analysis

III. Abstract

Introducing and implementing a new management method can be a daunting task for an organization. Open innovation is one such management method that requires intensive organizational change in order to implement it successfully. This paper addresses the process of implementing open innovation on the basis of a multi-step organizational change management approach. Our study leans on the method described by Armenakis and Bedeian (1999) who suggest a three-phase approach for organizational change process – unfreezing-moving-institutionalizing. We use this three-phase approach as the theoretical foundation for the development of a framework for step-wise implementation of open innovation through the building and utilization of certain management capabilities. Building on the work of Chiaroni et al. (2011) we identify the processes and resources that companies implementing open innovation build up gradually, and then based on a sample of 756 companies we show empirically that these capabilities are important requirements for the implementation of open innovation. Thus, the paper uses established concepts in change management research to analyze a rich empirical database that documents the capabilities built by companies that are at different stages of open innovation. We find that organizations can ensure effective implementation of open innovation by building on four management capabilities at a stage-based level: internal processes to encourage knowledge creation, sharing and utilization within and outside firm boundaries; external networks comprised of known entities external to the organization; global networks for accessing global knowledge through intermediaries, tech scouts, consortia; and capabilities directed toward efficiently leveraging external knowledge and integrating it into the internal R&D activities.

Keywords: Open innovation; intermediaries, broadcast search; implementation; change management.

Status:

1. Accepted for presentation: R&D Management Conference, June 23-26, 2015, Pisa, Italy.

Successful and Sustainable Implementation of Open Innovation: An Empirical Analysis

III.1. Introduction

Introducing and implementing a new management method can be a daunting task for an organization. In the absence of a systematic, well-defined change process, companies often fail in implementing a new management method (Kotter, 1995). Open Innovation is one such Management Method that requires a deep organizational change within the innovating firm (Chiaroni et al., 2011). Open Innovation – a way for organizations to go beyond their own four walls in order to find, or inspire new knowledge, ideas, and technologies (Chesbrough, 2003) – requires transforming the firm’s closed boundaries into a semi-permeable “membrane” enabling innovation to move easily between the external environment and the firm’s internal innovation process (Chiaroni et al., 2011).

Since the early work of Henry Chesbrough (Chesbrough, 2003) open innovation has caught the interest of academia, and has become one of the most discussed topics in recent management literature (Christensen et al., 2005; Dodgson et al, 2006; Gassmann et al., 2010; Huizingh, 2011; Martinez, 2013; West et al., 2014; Diener et al., 2015). However, the majority of open innovation articles deals with the front-end, with a focus on obtaining innovations from external sources (West and Bogers 2014). The process at the back-end, namely the ultimate implementation of the method as a management method for the acquisition of external technological knowledge has hardly been researched. What’s more, those few studies on the back-end part have been in the context of case studies involving a single or only a few companies (Huston and Sakkab, 2006; Haour, 2004; Kirschbaum, 2005; Chiaroni et al., 2010; Chiaroni et al., 2011; Luettgens et al. 2012). Thus, a holistic framework based on empirical analysis of a large number of companies, across industries and regional boundaries is clearly lacking.

This paper attempts to fill this gap by examining the process of implementation of open innovation. Our study adopts the framework used by Chiaroni et al. (2011) where the implementation of open innovation is seen as an organizational change management process. As Chiaroni et al (2011) mentioned, introducing and implementing open innovation requires deep changes at various levels within an organization, and hence in order to ensure successful and sustainable implementation of open innovation, the process needs to be carefully designed so as

to avoid common pitfalls. For this reason, we adopt the approach of change management and apply it to the process of implementing open innovation. Our study leans on the method described by Armenakis and Bedeian (1999) who suggest a three-step approach for the organizational change process – unfreezing-moving-institutionalizing. In simple terms, the unfreezing phase is defined by the identification of potential crises and untapped opportunities, and the creation and communication of a vision to direct the change effort. The moving phase involves the implementation of change by altering systems, structures and policies, consistent with the new vision; whereas the institutionalizing phase involves incorporating the newly developed approach into the organizational system. We re-apply this three-step approach to the process of implementation of open innovation. Thus, we define a company implementing open innovation as going through three phases, from rather “closed innovation” to “early-stage open innovation” to “intensive use of open innovation”. At each of these phases, companies build certain management capabilities that aid them in practicing open innovation. This paper first identifies these possible management capabilities by means of literature analysis, and then goes on to identify which of these management capabilities are developed at which phase in the process of open innovation implementation, by means of empirical analysis. This latter part is done with the help of a multinomial logistical regression analysis based on responses to an online survey from 756 organizations performed by NineSigma, an open innovation intermediary. In this way, using the theoretical framework of organizational change management process this paper shows empirically how firms build capabilities. This paper contributes to scientific literature by first identifying the capabilities that are built by companies that use open innovation intensively. Then, by comparing this to the capabilities built by companies that are at an early stage of open innovation, we determine the sequence in which capabilities are built. The paper also shows through empirical analysis that companies that aren’t able to build the pertinent capabilities aren’t able to “implement OI” successfully (Lewin et al., 2011; Salge et al., 2012; Alexy et al. 2013; Laursen and Salter 2014). This empirical analysis, based on real-world practices, covers a large number of companies across different industries, regions and sizes, and may prove to be an effective guide for organizations wanting to introduce and implement open innovation.

The paper thus attempts to answer the following main research question:

“Which capabilities do companies build at which stage of their change management process in order to successfully implement Open Innovation as a management system?”

The paper is structured as follows: Section 2 develops the theoretical and empirical background for gathering and interpreting data. Section 3 describes the management capabilities

and their theoretical anchoring, and draws out the hypotheses. Section 4 discusses the data, measurement parameters and statistical approach, while Section 5 comments on the results of the empirical analysis. Section 6 provides a summary of the key features of a successful and sustainable open innovation implementation strategy, whereas Section 7 highlights the limitations of this study.

III.2. Literature Review

As pointed out in literature (Chesbrough, 2006; Chiaroni et al., 2010; Boscherini et al., 2013) open innovation does not only involve the strengthening of a firm's relationships with external organizations and networks. Rather, it involves a holistic change at various organizational levels within an organization in order to take advantage of internal and external opportunities. Thus, adopting open innovation involves significant cultural and organizational change. For this reason, we approach the implementation process from the perspective of change management. Research on the implementation of organizational change has its origins in the work of Lewin (1947), where change management is described as a three-phase process consisting of: unfreezing, moving and institutionalizing. The first phase involves identifying the potential crises and untapped opportunities, establishing a sense of urgency towards change, creating a team of champions for bringing about the change, and the creation and communication of a vision to direct the change effort. The second phase comprises the actual implementation of change by altering systems, structures and policies, consistent with the new vision. This phase involves a trial-and-error approach wherein early wins are used to shape further changes to better fit the new vision. The third phase involves institutionalizing the newly developed approach and creating succession plans consistent with the new approach (Kotter, 1995). Though the change management process may sound simple, Kotter (1995) points out that each of the stages is critical and needs to be given due attention and involvement. The process of implementing change advances through stages that build on each other. Skipping stages and accelerating the process may lead to failure. In order to ensure success in change management, it is important to understand the stages of change and avoid pitfalls unique to each stage (Kotter, 1995). Another hurdle to implementing change is the resistance to change offered by people who are affected by it (Judson, 1991). Thus, leading change is both essential and difficult. Based on the work of Lewin (1947), authors have created several multi-phase change management models, with up to twelve phases of the organizational change process (Judson, 1991, Kotter, 1995; Galpin, 1996; Clark et al., 1997). However, a careful analysis of these models suggests the additional phases to

be subdivisions of the original three-phase model of Lewin (1947). In the literature on organizational change, Armenakis and Bedeian (1999) bring back the original three-phase model proposed by Lewin and describe it as a simplified and holistic framework for future research on organizational change.

There are only few studies that apply the change management theory in the implementation process of open innovation. For example, Boscherini et al. (2010) who apply Lewin’s organizational change management theory to study the process of transitioning from closed to open innovation through pilot projects. Boscherini et al. (2013) note that Lewin's theory of organizational change can be applied to the process of transitioning from closed innovation to open innovation in the context of both high-tech as well as low-tech industries. However, these studies are limited to case studies.

Chiaroni et al (2011) adopt the original three-phase model and develop a step-based framework for the process of implementing open innovation. Firstly, they divide the concept of open innovation into its two basic dimensions – outside-in and inside-out open innovation. Secondly, they discuss the implementation of each dimension of open innovation as a three-step process based on organizational change management theory. And thirdly, the capabilities that promote and support the implementation process are introduced and discussed. This paper focuses on the outside-in dimension of open innovation, and describes the implementation process as a three-step organizational change management process, but distinguishes the management capabilities that are built during the organizational change process of a firm that is at an early stage of open innovation (i.e. transitioning from closed to open innovation), from those of a firm that is intensively using open innovation (i.e. institutionalizing its existing open innovation process). We adopt the Chiaroni et al. (2011) approach and use this framework as a starting point for our empirical analysis.

III.3. Framework and Hypotheses

Building on the framework of Chiaroni et al. (2011), we suggest certain capabilities that enable a company to go from one stage to the next during their transition from closed to open innovation. Figure III.1 illustrates a framework for the implementation of open innovation. The framework approaches the implementation process from the perspective of an organizational change management process. Hypotheses are established on pertinent activities (processes, networks, etc.) in relation to the implementation process.

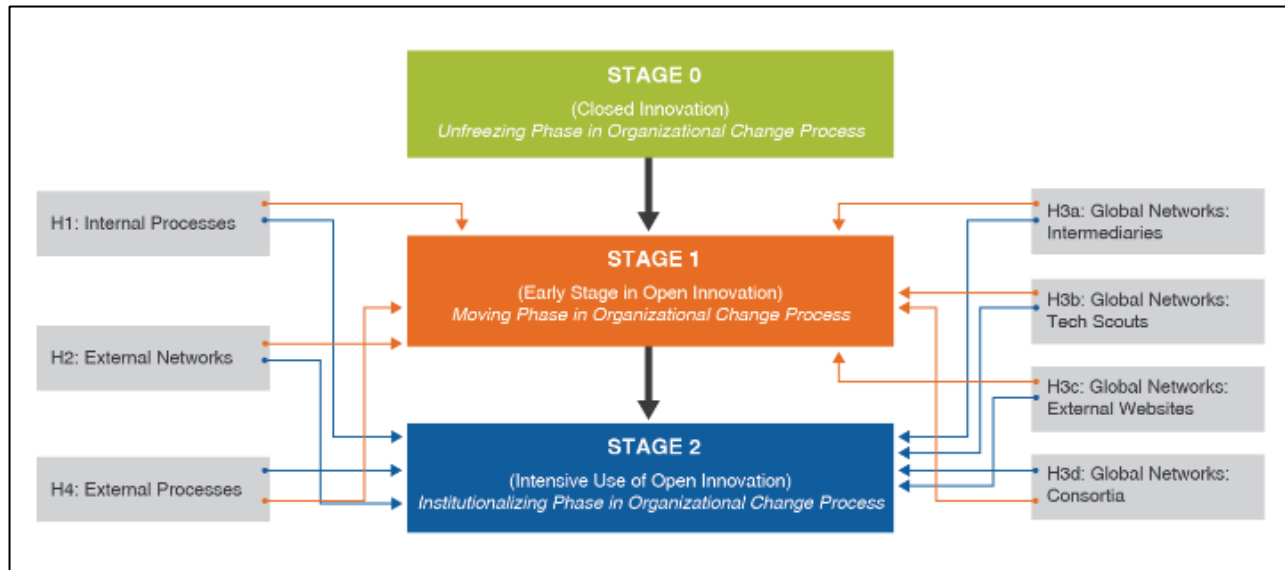


Figure III.1. Organizational change stages and hypotheses on capabilities.

III.3.1. Management Capabilities

In order to promote and support the implementation of open innovation, organizations build capabilities in the form of processes, skills and competences, and use certain resources. These processes and resources help the organization to acquire, assess, and disseminate internal and external knowledge and opportunities. This study, suggests such capabilities that companies implementing open innovation build up gradually. Thereby we follow the approach of micro foundations by Felin et al., (2012) who suggest that the building-blocks of capabilities can be grouped into three major categories: individuals, processes and structures.

III.3.1.1. Internal Processes

In the simplest sense, a process is a sequence of interdependent events. Internal processes in the context of this paper refer to the routines that companies build in order to acquire, assess and disseminate internal knowledge. Studies have shown that internal processes within a company are influenced by formal as well as informal forms of co-ordination (Becker, 2004). Some studies examine the impact and effects of formal coordination on processes (March et al., 2000; Hoopes and Postrel, 1999; Argote, 1982; Henderson and Clark, 1990). Other studies explain the influences of informal aspects of coordination such as culture, values, and experiences (Szulanski et al., 2004; Wilkins and Ouchi, 1983; Fauchart and Von Hippel, 2008; Jacobides and Billinger, 2006). The formalization of internal processes as a mechanism to promote internal knowledge

sharing between the business units, and also with external partners has been recognized in several studies (Zander & Kogut, 1995; Eisenhardt & Martin, 2000; Heimeriks & Duysters, 2007; Romme et al., 2010; Zollo & Winter, 2002). Consequently, some organizations develop processes to enable decentralized decision making within the company with the help of “cross functional” teams and regular collaboration meetings. This creates an informal and horizontal coordination between the involved business units of the company (Grant, 1996; Van den Bosch et al., 1999; Ghoshal et al., 1994). In this manner competition for internal resources between business units gets mitigated or even eliminated. For the support of the broader based intra-organizational use of internal resources, formal processes are established which help to identify new ideas and problem solutions (Lin & Germain, 2003; Kogut & Zander, 1993). Furthermore, knowledge management systems that foster the diffusion, sharing and transfer of knowledge within the firm, and between the firm and external environment act as an effective managerial lever in introducing open innovation to the employees in the firm (Chiaroni et al., 2011). The utilization of new knowledge depends on the processes firms put in place to select the various projects and activities to invest in and to determine how to allocate resources among them (Lewin et al. 2011). Such internal processes that encourage knowledge creation, sharing and utilization within firm boundaries enhance the absorptive capacity of the firm and are expected to serve as moderating mechanisms to help firms reap the potential benefits of eventual external knowledge sourcing and overcome the challenges likely to be encountered in this process (Salge et al., 2012; Lewin et al., 2011). Internal processes, on the one hand serve to promote and establish internal knowledge sharing within an organization, and on the other, support the absorption of external knowledge. In this way, internal processes positively impact the internal R&D capability of an organization (Helfat, 1994). Thus, internal capabilities comprise a bundle of different routines and capabilities that are critical for successful implementation of an open innovation program. We thus suggest:

Hypothesis 1: *Companies transitioning from no use of open innovation (stage 0) to intensive use of open innovation (stage 2) will build internal process capabilities between stage 0 and stage 1 so that it will be shown to be present at both stage 1 and stage 2.*

III.3.1.2. External Networks

External networks, and collaborations with external partners are effective ways to acquire external knowledge, and companies have been increasingly interacting with outside organizations to exchange and cogenerate knowledge (Chesbrough 2003; Lewin et al. 2011; Bessant et al., 2012; Clausen, 2013). R&D partnerships in the form of close collaborations for the development

of new knowledge and new technologies may be launched with universities and research institutes, but also with customers, suppliers and even competitors (Tether 2002). Several studies suggest that a firm’s openness to its external environment, made possible by the presence of a sufficiently broad network of external partners, positively impacts the firm’s innovative performance (Dittrich & Duysters, 2007; Nieto and Santamaría, 2007; Zeng et al., 2010; Laursen and Salter, 2006). External partners may include suppliers (Li and Vanhaverbeke, 2009; Schiele, 2010), consumers (Gassmann et al., 2006), competitors (Lim et al., 2010), universities (Cassiman et al., 2010), public and private research organizations (Jeppesen & Lakhani, 2010), and online communities (e.g. Dahlander and Wallin, 2006). R&D partnerships and networks involve, at least to some extent, a mutual access to the partners’ knowledge bases, and therefore access to external knowledge that might not be publicly available. However, building external networks and R&D partnerships takes time, and they build up gradually. Furthermore, success with managing such alliances requires development of stable patterns of collaboration between the partners (Zollo et al. 2002). Successfully managing external networks requires development of complementary internal structures devoted to accessing and utilizing external networks and integrating the acquired knowledge into the company’s innovation process. In this context, a knowledge management system (in the form of a technological platform and ICT tools), equipped with an appropriate intellectual property management system to capture information and solutions from across the company’s external network, will ensure that the company’s innovation network is fully utilized (Chiaroni et al. 2011). A sufficiently broad network of external partners (Laursen and Salter, 2006), together with an efficient innovation management system to access and utilize knowledge gained from these networks, form an important capability for a company practicing open innovation (Chiaroni et al., 2011). These arguments and findings lead to our next hypothesis:

Hypothesis 2: *Companies transitioning from no use of open innovation (stage 0) to intensive use of open innovation (stage 2) will build external network capabilities between stage 0 and stage 1 so that it will be shown to be present at both stage 1 and stage 2.*

III.3.1.3. Global Networks

Going beyond the traditional innovation networks with (well) known customers, suppliers and universities, companies may use global networks in order to acquire, assess and disseminate global knowledge. Global networks mean a large group of unknown “outsiders” that may have the capability to solve a problem. Global networks are comprised of scientists and researchers

from diverse fields of science and technology, and provide a heterogeneous problem solving perspective that can rarely be obtained from existing external networks of companies (Lakhani et al., 2006). Furthermore, Lakhani and Jeppeson (2007) suggest that radical innovations often happen at the intersection of disciplines. Additionally, a diverse problem-solving population has better chances of solving a problem than an active search for a solution with a clear presumption about its location and composition (Piller, 2010). It has been shown that opening up to global networks can alleviate the negative effects of local search (Lakhani et al., 2006). A recent trend in this area involves opening up firms’ innovation processes to external contributors, through for instance, posting innovation challenges on the internet, managed by innovation intermediaries, or by adopting open source software (Lewin et al. 2011). A firm may initiate a “broadcast search” problem solving process by publishing details of the problem to a global network and inviting the participation of anyone who may be able to provide a solution to the problem. Interested solution providers share their proposals with the organization seeking their solutions, and are rewarded if successful (Jeppeson and Lakhani 2010). The effectiveness of broadcast search has been illustrated by many examples in literature (Jeppeson and Lakhani 2010; Felin and Zenger 2013; Luettgens et al. 2014), and an important attribute of broadcasting problems to the global network is that unexpected individuals – that is, those from adjacent disciplines or from industries other than that the problem originated from – can develop solutions to problems when there is an open invitation to participate (Jeppeson and Lakhani 2010). Hence, building the resources and the ability to access the global innovation community and collaborate with solution providers beyond its existing network adds value to an organization’s innovation efforts. There are multiple channels for companies to access global knowledge through global networks: companies may build their own organizational competences by means of corporate tech scouts and external websites to capture innovation ideas from the outside, as well as use existing global networks of open innovation intermediaries, consortia and other collaborative activities. Thus, “global networks” is a bundle of different resources that together form an organization’s aggregated capability to access the global innovation community. However, each of these channels works independently from one another and the building and adoption of these channels by an organization is also mutually independent. It may hence be worthwhile to separately identify how significant each of these channels is to the implementation process and also at which stage of the change management process. For this reason, we divide “Global Networks” into four subcategories, namely intermediaries, tech scouts, consortia, and external websites, and test the significance of each at each stage of implementation of open innovation.

III.3.1.3.1. Intermediaries

Intermediary organizations specialized in open innovation act as intermediary between a "searcher"-an organization with an open innovation problem and "solvers"-a network of organizations or individuals with potential solutions (Chesbrough and Brunswicker 2014). The role of intermediaries in developing, accelerating, and controlling the knowledge and dynamic competences necessary to solve complex innovation problems, and in fostering the diverse linkages between various geographically dispersed entities or innovation networks has been well documented (Howells, 2006; Boudreau and Lakhani, 2009; Luettgens et al., 2012; Roijakkers et al., 2014). Intermediaries assist organizations in broadcasting their technology needs in the form of written problem statements (request for proposal) to invite a wide range of solution providers to submit solution proposals to technological problems the organization is unable to solve on its own (Jeppesen & Lakhani, 2010; Sieg, Wallin, & von Krogh, 2010; Terwiesch & Xu, 2008; Bourdeau, Lacetera, & Lakhani, 2011). Several studies indicate that strategically disclosing (selectively revealing) problem related knowledge through intermediaries in the form of (tournament-based) crowdsourcing (Afuah & Tucci, 2012) or broadcast search (Jeppesen & Lakhani, 2010) may substantially reduce organizations' search costs for external knowledge and collaboration partners. Thus, intermediaries serve as an alternate knowledge capability and (at least during early phases) do not require intense organizational changes at a structural level. Due to the low barrier in utilizing the services of open innovation intermediaries, it we assume that companies wanting to introduce open innovation will use intermediaries at an early stage of implementing open innovation. Hence we propose our next hypothesis:

Hypothesis 3a: *Companies transitioning from no use of open innovation (stage 0) to intensive use of open innovation (stage 2) will build capability to use intermediaries between stage 0 and stage 1 so that it will be shown to be present at both stage 1 and stage 2.*

III.3.1.3.2. Tech Scouts

Corporate tech scouts are another means for an organization to access global knowledge. Tech scouts play a twofold role in an organization: firstly, they identify advances in science and technology that can be of use for the company – this can either be a directed search in a specific technological area, or an undirected search for new technological opportunities in white spaces, and secondly they facilitate or execute the sourcing of technology (Rohrbeck 2006). The tech scout may either be an employee of the company or a consultant. The desired characteristics of a tech scout include: lateral thinking, knowledgeable in science and technology, respected inside the company, cross-disciplinary orientation and imagination (Wolff 1992). Tech scouts offer a

competitive advantage by early identification of opportunities and threats arising from technological developments and provisioning of the needed technology capabilities. Thus, technology scouting is a systematic approach by companies of assigning part of their staff or employing external consultants to gather information in the field of science and technology and to help facilitate or execute technology sourcing (Rohrbeck 2006). Lichtenthaler (2003) highlights the importance of “technology intelligence specialists” over the last 30 years in large technology intensive companies. The use of people and their personal networks for technology scouting is well established and companies have been using tech scouts for technology foresight and sourcing activities (Rohrbeck 2010). For this reason, we propose the following hypothesis:

Hypothesis 3b: *Companies transitioning from no use of open innovation (stage 0) to intensive use of open innovation (stage 2) will build capability to use tech scouts between stage 0 and stage 1 so that it will be shown to be present at both stage 1 and stage 2.*

III.3.1.3.3. External Websites

In recent years, the internet has become a new channel for companies to access global knowledge. Companies are increasingly turning to the internet to post their innovation needs and invite solutions from anyone who may have one (Balaneji et al., 2013). These external facing websites are hosted and maintained by the companies themselves, or by third parties, and can be seen as a mediator between external solution providers and the R&D department of companies that seek experts to solve problems. Several large companies have their own external facing open innovation websites (Balaneji et al., 2013). Building and maintaining an external facing web platform incurs a nominal cost to the company, and does not involve any substantial change at a structural level. Thus, it might require relatively little time, cost and effort to build and maintain an external facing website. Hence our next hypothesis:

Hypothesis 3c: *Companies transitioning from no use of open innovation (stage 0) to intensive use of open innovation (stage 2) will build capability to use external facing websites between stage 0 and stage 1 so that it will be shown to be present at both stage 1 and stage 2.*

III. 3.1.3.4. Consortia

Participation in R&D consortia with other public or private organizations provides a unique opportunity for companies to interact with the academic community as well as with industry peers. Consortia act as “boundary organizations” that allow firms, through mediated revealing, to disclose R&D problems while minimizing adverse competitive consequences (Perkmann and

Schildt 2014). Consortia stimulate cumulative innovation by engaging a broader community of innovators (Perkmann 2009). Hence our next hypothesis:

Hypothesis 3d: *Companies transitioning from no use of open innovation (stage 0) to intensive use of open innovation (stage 2) will build capability to use consortia between stage 0 and stage 1 so that it will be shown to be present at both stage 1 and stage 2.*

III.3.1.4. External Capabilities

Building a capacity to access external knowledge from existing external partners and global innovation communities is important, and fully exploiting the gained external knowledge in a meaningful way is equally important. Companies need certain processes and network structures to leverage the external knowledge and integrate it into the internal R&D activities (West and Bogers, 2014). The goal is to promote collaboration through structural changes and measures that support the integration of external knowledge into the internal processes by creating the right innovation culture and mindset within the organization. This helps in overcoming the “Not-Invented-Here Syndrome” (West and Bogers, 2014). Literature suggests two possible measures in order to establish an open innovation culture within the company: on the one hand, the identification of so-called champions that endorse, promote and lead efforts that leverage external innovation activities (Gemünden et al., 2007), and on the other, the introduction of incentives and reward systems that support engaging with external innovation partners (Fu, 2012). The use of so-called champions – individuals with a passion for new ideas and open innovation – has been recommended in several studies (Howell et al., 2005; Roure, 2001. Gemünden et al, 2007; Sicotte and Langley, 2000; Lichtenthaler et al., 2011). The formulation of objectives and introduction of an incentive and reward system increases the likelihood of more frequent and more intensive development and adoption of innovations (Lewin et al., 2011). The objectives may be both long term and short term (Fu, 2012). In addition to promoting the use of external and internal knowledge, such incentive schemes also develop a positive attitude towards intra- and inter-organizational knowledge sharing (Minbaeva, 2003) and an innovation culture of joint problem solving (Hargadon & Sutton, 1997). Finally, organizations increase their absorptive capacity through monetary and non-monetary rewards for the development, combination and absorption of new knowledge and solutions among employees (Foss et al., 2011).

A robust evaluation process for solutions coming from external sources is becoming increasingly important in implementing open innovation. New metrics of evaluation that focus

more on external sources and paths of innovation, and procedures to systematically scan and continuously monitor the range of technologies available in the external environment ensure that companies create maximum value from their external innovation activities (Chiaroni et al., 2011).

In addition to building structures and processes, companies need certain technical capabilities to integrate and utilize external knowledge. A knowledge management system that records and indexes all external knowledge acquired and at the same time provides easy access to a well-defined group of employees facilitates the diffusion, sharing and transfer of knowledge from outside sources into the organization (Chiaroni et al., 2010). Our next hypothesis thus follows:

Hypothesis 4: *Companies transitioning from no use of open innovation (stage 0) to intensive use of open innovation (stage 2) will build external process capability between stage 0 and stage 1 so that it will be shown to be present at both stage 1 and stage 2.*

III.4. Data and Method

III.4.1. Statistical Method

Since this paper involves choice situations characterized by many alternatives, we used the Multinomial Logistic Regression methodology that is appropriate for testing models where utility differences determine the probability of selection amongst a series of discrete choices (Hausman and McFadden, 1984; Folta and Leiblein, 1994). The stages of the implementation process of open innovation formed the dependent variable, whereas the management capabilities formed the independent variables. We also introduced some control variables in order to account for differences in firm-level attributes such as firm type, industry, and location. This way we test the significance of each management capability (independent variable), on the respective stage (dependent variable) of the implementation process.

III.4.2. Data

Data for this empirical analysis were taken from a survey called “the NineSigma Open Innovation Diagnostic Tool”, which provides snapshots of open innovation capabilities of participating organizations. The survey started with questions on the background of the organization, six questions to assess their current open innovation skills, and three open questions. The sample

used for this study consists of responses from 756 organizations, grouped based on their type, industry and region. The responding firms are distributed across many different industries ranging from consumables, to biotechnology, to aerospace and aviation. Our study thus extends prior open innovation research that tended to focus primarily on manufacturing firms (Laursen and Salter 2006). As for the types of organizations, the study spans across corporates, universities, consulting companies, laboratories and non-profit organizations. The sample data is not location-specific and covers companies from across the world, unlike other studies such as Salge et al (2012) that focuses on German firms and Laursen and Salter (2006) that focuses on English firms. To assess whether our survey was subject to non-response bias, we compared our final sample to the early respondents against late respondents. The latter did not indicate any significant differences. Appendix A1 provides the descriptive statistics and bivariate correlation for the central variables. Multicollinearity was not a concern.

III.4.3. Measurement Parameters

III.4.3.1. Dependent Variables

For the development of the dependent variable, this study uses information provided by the participating organizations to an introductory question on the current status of the organization’s open innovation activity. The question asks the participants to describe their organization’s open innovation activity and have the following four possible answers: (1) Not involved in open innovation; (2) Early stages of open innovation introduction and adoption; (3) Optimization of an ongoing open innovation program; (4) Re-establishing an open innovation program. From this question, we constructed the three categories – Closed Innovation, Early Stage, and Intensive Use – that eventually form the three stages in the process of implementation of open innovation. The category “Closed Innovation” describes all organizations with answer (1) that are not involved in open innovation. The category “Early Stage” describes all companies with response (2). The last category “Intensive Use” reflects all organizations with answer (3) or (4).

III.4.3.2. Explanatory Variables

This study developed four explanatory variables, representing the management capabilities, based on four questions in the survey. For testing Hypothesis 1 relating to “Internal Processes”, responses to a question in the survey were used, where participants were asked to indicate on a

five-point scale how strongly some processes exist in the organization. These processes are: (1) Regularly scheduled meetings that foster collaborative innovation; (2) A formal process to identify new ideas from across the company; (3) A knowledge management system that captures organizational knowledge and solutions; (4) A structured process to convert ideas into innovation projects. All these processes together form an organization’s capability to support internal knowledge creation, sharing and utilization within the organization. In order to test the influence of “Internal Processes”, this study calculated the average of the respective response values to each of the four processes as mentioned above.

The explanatory variable “External Networks” – the capability examined in Hypothesis 2, was tested based on responses to a question that probes the number of external partners an organization uses within its existing innovation network. Participants were asked to choose from a list of innovation partners: suppliers, university partners, customers, government (local, national, regional) and others. The sum of the number of partners chosen indicated the breadth of the organization’s existing innovation network. In this way, early stage open innovators were compared with intensive users for the breadth of their external innovation networks.

“Global Networks” was divided into four sub-categories in order to test Hypotheses 3a, 3b, 3c, and 3d. Responses to a question on resources available with the organization to help access the global innovation community were used. Participants had to choose from a list of resources: open innovation intermediaries, corporate tech scouts, external website to capture innovative ideas and consortia or other collaborative activities. Each of the four capabilities were analyzed separately for their significance as a tool to access global networks at different stages of implementing open innovation. This question served as an indicator of which of the resources organizations build and use to access global networks and at which stage of implementing open innovation.

Likewise, to test Hypothesis 4 based on “External Capabilities”, participants were asked to indicate on a five-point scale how extensively some processes have been implemented in the organization. These processes are: (1) People designated to lead efforts that leverage the (external) global innovation community; (2) A reward/incentive system for employees that supports engaging with external innovation partners; (3) A formal structure to evaluate and acquire solutions that come from external sources; (4) All the right people involved to expedite the external technology acquisition process (e.g. R&D, Purchasing, Marketing, Legal, etc.). All these processes enlisted above serve to collectively build an organization’s capability to control the access and utilization of external knowledge. In order to test the influence of “External

Capabilities” for this paper we calculated the average of the respective response values to each of the four processes as mentioned above. Cronbach’s Alpha for all variables were higher than 0.8 indicating that the aggregated scales as well as the sub-variables in this study are all reliable and are in accordance with the validity of measures.

III.4.3.3. Control variables

We introduced some control variables in order to account for differences in firm-level attributes such as firm type, industry, and location. First, we account for differences in the types of the organizations that have participated in the survey: (1) Companies; (2) Universities; (3) Consulting; (4) Laboratories; and (5) Non-profit organizations. Second, we control for firm location by grouping the firms based on the region in which they are located. Lastly, we

Table III.1. Regression models.

	Model I(Baseline Model)		Model II	
	Early-stage OI	Intensive use of OI	Early-stage OI	Intensive use of OI
<i>Control variables: Firm type</i>				
Corporate	-0.040 (0.540)	0.009 (0.060)	-0.054 (0.057)	-0.040 (0.071)
University	0.145 (0.288)	-0.110 (0.339)	0.092 (0.308)	-0.225 (0.390)
Consulting	0.529 (0.293)*	0.825 (0.307)***	0.384 (0.311)	0.545 (0.360)
Lab	-0.868 (0.431)**	-0.018 (0.381)	-0.909 (0.443)**	-0.118 (0.454)
Non-profit	0.791 (0.463)*	0.959 (0.510)*	0.965 (0.482)**	1.453 (0.574)*
<i>Control variables: Firm location</i>				
North America	-0.218 (0.233)	-0.117 (0.263)	-0.324 (0.247)	-0.442 (0.315)
Europe	0.099 (0.235)	0.253 (0.259)	0.043 (0.247)	0.102 (0.305)
Asia	0.650 (0.428)	1.145 (0.444)**	0.416 (0.445)	0.791 (0.500)
South America	-0.055 (0.409)	0.296 (0.431)	0.054 (0.429)	0.568 (0.500)
Africa	-0.891 (0.519)*	-0.843 (0.595)	-0.767 (0.536)	-0.427 (0.666)
<i>Control variables: Firm industry</i>				
Research	-7.694 (8.620)	-8.437 (9.650)	-5.640 (9.020)	-10.507 (11.174)
Consumable	-6.700 (7.993)	-7.114 (8.948)	-4.686 (8.361)	-8.656 (10.357)
Biotechnology	-6.525 (7.374)	-7.602 (8.256)	-4.780 (7.715)	-9.297 (9.560)
Industry	-5.937 (6.754)	-7.114 (7.563)	-4.232 (7.063)	-8.312 (8.750)
Chemical	-5.501 (6.128)	-6.031 (6.869)	-4.076 (6.420)	-7.373 (7.952)
Education	-5.037 (5.531)	-5.851 (6.191)	-3.616 (5.794)	-6.926 (7.165)
Electronics	-4.352 (4.903)	-4.281 (5.481)	-3.193 (5.131)	-5.483 (6.344)
Telecommunication	-4.247 (4.294)	-4.263 (4.798)	-2.987 (4.491)	-4.785 (5.555)
Food and Beverage	-2.965 (3.668)	-3.724 (4.108)	-2.026 (3.832)	-4.130 (4.748)
Automotive	-2.124 (3.068)	-1.754 (3.420)	-1.509 (3.206)	-2.480 (3.954)
Aerospace	-0.222 (2.501)	-0.474 (2.784)	-0.050 (2.612)	-1.796 (3.209)
Material	-1.118 (1.832)	-3.167 (2.148)	-0.809 (1.915)	-3.564 (2.450)
Utility	-0.120 (1.304)	-0.146 (1.453)	0.018 (1.360)	-0.458 (1.662)
<i>Independent variables</i>				
Internal processes (H1)			0.176 (0.117)	0.434 (0.151)***
External networks (H2)			0.161 (0.088)*	0.395 (0.108)***
Global knowledge: Intermediaries (H3a)			0.985 (0.273)***	1.459 (0.291)***
Global knowledge: Tech scouts (H3b)			0.816 (0.254)***	0.833 (0.287)***
Global knowledge: External websites (H3c)			0.285 (0.216)	0.216 (0.257)
Global knowledge: Consortia (H3d)			0.031 (0.231)	0.682 (0.260)***
External capabilities (H4)			0.073 (0.120)	0.535 (0.150)***
Constant	8.465 (9.223)	8.957 (10.328)	4.781 (9.657)	6.316 (11.953)
Log likelihood	-777.94		-667.31	
Prob>Chi²	0.0002		0.0000	
Pseudo R²	0.0551		0.1895	

Notes: Number of observations = 756. Standard errors in parentheses. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

introduced a full set of industry dummies to capture inter-industry differences (Table III.1).

III.5. Results

We used the multinomial logit methodology for this paper, and in order to check for the reliability of scales, we used the Cronbach’s Alpha measure.

While our baseline model (Model I) includes only controls, Model II tests the significance of the management capabilities at each stage of implementation of open innovation (Hypotheses 1-4). Our empirical findings are listed in Table III.1.

In Hypothesis 1, we predicted that internal processes that promote and support internal knowledge sharing and external knowledge absorption may be built at early stages of open innovation implementation and its use continues at later stages of intensive use. However, the analysis shows that the coefficient for internal processes is not significant at the early stage, but becomes significant only at the stage of intensive use. This means that companies tend to build internal processes only after they have gained sufficient experience with practicing open innovation. This result is somewhat surprising since we’d expect that companies that decide upon introducing open innovation would start-off with building internal processes and routines that increase the organization’s absorptive capacity (Lewin et al., 2011). Presence of internal processes such as incentive systems and cross-functional collaborations within the organization positively influence the returns from open innovation (Dahlander and Gann, 2010; Salge et al., 2012). The contrary finding might stem from the fact that building internal processes is not a simple task, but requires a significant change within the organization. It is well known from change management literature that organizational change efforts tend to face resistance and it does take considerable amount of time to successfully implement a change (Judson, 1991). Change management literature also points to a behavioral theory that states that short-term achievements are essential in keeping the momentum of change alive. Kotter (1995) aptly quotes “most people won’t go on the long march unless they see compelling evidence in 12 to 24 months that the journey is producing expected results”. For this reason, companies might start out with building “easier” and less incisive capabilities. Only after gaining more experience (and success) in building other capabilities will they invest time and effort in taking more difficult, but essential steps such as building internal processes and routines.

To test the significance of the capability of using external networks at various stages of implementation of open innovation, the variable “External networks” was introduced in Model II. The results obtained for this variable support Hypothesis 2, confirming that broad external

networks comprised of external partners known to the organization, such as customers, suppliers, and research collaborations, are built at an early stage of implementing open innovation. This finding is in line with papers that suggest that companies routinely interact with outside organizations such as suppliers to exchange and cogenerate knowledge (Chesbrough 2003; Lewin et al. 2011; Bessant et al., 2012; Clausen, 2013). Thus, external networks are present within a company at an early stage of open innovation, and companies systematically keep broadening their external networks and harnessing them even at a later stage as well.

Hypotheses 3a,b,c,d test the significance of the four subcategories of the capability of accessing global knowledge networks – intermediaries, tech scouts, external websites, and consortia – at stages 1 and 2 of open innovation implementation. The results from the empirical analysis support Hypotheses 3a and 3b. Using an open innovation intermediary can be done by involving few internal and external stakeholders and does not require lot of internal re-organization early on. Likewise, appointing a tech scout (either through a full, or part time employee, or an external consultant) is relatively easy and does not involve any significant amount of organizational change. The results do not support Hypothesis 3c and suggest that external websites are not significant at any stage of implementation of open innovation. This might be because building and maintaining an external website may not be particularly difficult, but attracting sufficient traffic to the websites in order to meaningfully gain from such an initiative is challenging. That’s why companies participating in the survey may have chosen to not use websites, but intermediaries and tech scouts to build this capability as shown above. The results also suggest that consortia are built and used only at a later stage of open innovation implementation, contrary to Hypothesis 3d. The process of identifying appropriate opportunities and then participating in consortia is usually a complicated and advanced process that companies may not invest in at an early stage of opening up.

The capability to build external processes that leverage external knowledge and integrate it into internal R&D activities comes only at a later stage of open innovation implementation, as opposed to the prediction of Hypothesis 4. Building external processes requires multiple changes at the organizational level and is an intense initiative. Hence, companies may tend to build this capability only after gaining experience in open innovation through “easier” activities such as using intermediaries and tech scouts.

The results from this analysis serve to validate that management capabilities are built-up gradually and in a step-wise manner in the process of implementing open innovation. Companies need not and do not build all pertinent management capabilities at the onset, but will build them

up as they proceed through their journey of implementing open innovation. As can be seen in Table III.1, the results are robust with respect to the control variables, namely firm type, location and industry. Thus, the findings from this paper suggest that they apply across different types of firms, located at different regions around the world, and from a variety of different industries.

III.6. Summary and Conclusions

This paper provides a framework for step-wise implementation of open innovation through the building and utilization of certain management capabilities. The goal was to create a holistic framework for the implementation process that would be applicable across different types of organizations, from different industries, and with different locations in general. Open innovation is a management method that requires intensive organizational change in order to implement it successfully (Chesbrough 2006). This study adopts the framework of organizational change management to address the process of implementing open innovation at three distinct stages (Chiaroni et al. 2011). Directing attention to the micro-foundations of management capabilities (Barney & Felin, 2013; Felin et al., 2012; Gavetti, 2005; Lewin et al., 2011) our study provides important insight into the issue of capability development at the different stages of implementation. More specifically we find that organizations can ensure effective implementation of open innovation by building on four management capabilities: internal processes, external networks, global networks and external capabilities at a stage-based level. The results of our paper show that these capabilities are important requirements for the implementation of open innovation.

Our findings suggest that companies take the “path of least resistance” when implementing open innovation as an organizational change. Companies typically start with using the services of intermediaries and tech scouts to access global knowledge. Out of all management capabilities considered in this study, accessing global networks through intermediaries and tech scouts require the least amount of change efforts, and hence companies tend to begin their open innovation journey through these sub categories. This finding confirms pertinent management literature that suggests that any organizational change process will encounter significant resistance from the people most affected by the change (Kotter 1995; Judson, 1991). Change management literature also suggests that in order to maintain the momentum of a change effort, it is imperative to assign short-term goals and achieve short-term wins (Kotter 1995). Approaching an intermediary or appointing a tech scout for a few initial open innovation projects offers the opportunity for the organization to gain experience and test the impact of the change. Only after the organization has

had experience with these initial projects, it moves on to further refining the open innovation process by building additional capabilities such as internal processes to encourage knowledge creation, sharing and utilization within and outside firm boundaries, and thereby increasing its absorptive capacity (Salge et al. 2012; Lewin et al., 2011); broadening and efficiently managing its external networks comprised of known entities external to the organization (Laursen and Salter 2006), further increasing its access to global knowledge by joining consortia and other collaborative activities (Perkmann 2009), and building capabilities directed toward efficiently leveraging external knowledge and integrating it into the internal R&D activities (West and Bogers 2014). A surprising finding is that companies wait on building internal processes that foster internal and external knowledge sharing and utilization, and do so only after they've had an initial experience with open innovation. Presence of internal processes such as incentive systems and cross-functional collaborations within the organization are known to positively influence the returns from open innovation (Dahlander and Gann, 2010; Salge et al., 2012), and delaying this essential requirement to a later stage may negatively impact the results from the initial open innovation projects.

In this way, this quantitative study confirms the results of some qualitative research case studies on the influence of certain management skills, structures, and capabilities on the implementation of open innovation (Buganza et al, 2011; Huston and Sakkab, 2006; Haour 2004; Dittrich & Duyster, 2007; . Tao and Magnota, 2006; Kirschbaum 2005; Boscherini et al., 2010). In addition, this study extends the research field by providing a holistic framework for the process of implementing open innovation. On the one hand, this study builds on the framework of Chiaroni et al. (2011) and expands it, and on the other hand, highlights by means of an empirical analysis the importance of certain management skills and capabilities for successful implementation of open innovation (Lichtenthaler and Lichtenthaler 2009; Salge et al. 2012). Boscherini et al. (2010) and (2013) also lean on the change management theory to study open innovation implementation. However, those are case-study based research work. This study extends the current viewpoint on implementing open innovation as a change management process, by going beyond case study research into the domain of empirical research involving a rather large number of organizations across different industries and regions. Our quantitative study extends work on the research field that considers the implementation of open innovation as a step-based process (Chiaroni et al. 2011; Mortara and Minshall 2011; Buganza et al. 2011). Furthermore, our paper extends into the research area of dynamic capabilities, explained by the build-up of processes, routines and skills (Alexy et al. 2013; Foss et al, 2011; Laursen & Salter, 2014) and confirms the reasoning of Rothaermel & Hess (2007) that skills at individual, corporate

and network level be established in order to implement open innovation. Finally, results from this study fit well into the approach of micro-foundations (Felin et al., 2012) wherein we show how key individuals (for e.g. tech scouts, champions), process formality (e.g. formalization of internal and external processes), and dedicated organizational structures (e.g. innovation incentive and reward systems) are built in order to successfully implement open innovation.

III.7. Limitations

This study provides new insights into the implementation process of open innovation in organizations. However, there are some limitations to this study as highlighted below.

First, this study analyses the capabilities and expertise currently existing in the respective organizations that promote and support the implementation of open innovation, but does not analyze whether the organizations used in the sample data are successful in implementing open innovation or not. However, there are studies that show the positive influence of certain processes, routines and capabilities on the development of a dynamic capability (Alexy et al, 2013; Foss et al, 2011; Laursen and Salter, 2014) or a dynamic absorptive capacity (Lewin et al. 2011; Salge et al. 2012). In addition, there are several case studies that illustrate the positive influence of each of the management skills and capabilities outlined in this study on the implementation of open innovation (Buganza et al. 2011; Huston and Sakkab 2006; Dittrich and Duyster 2007). As a result, this study assumes that organizations in the sample data that successfully constructed management processes, skills and capabilities to promote open innovation are successful in implementing open innovation. Future studies in this area should look at other success factors of responding organizations, like additional revenue through open innovation etc. in order to determine that the companies are indeed successfully using open innovation.

Second, this study is based on data obtained from a survey conducted by NineSigma, an open innovation intermediary. NineSigma’s core area of service is the broadcast search method of open innovation and hence the sample population for this study is more about companies that use/ are planning to use the broadcast search method. Findings of this study are more applicable for the broadcast search method of open innovation, than other open innovation methods.

Third, the study has a “single information bias” and is a subjective assessment of the respondents. Further refinement of this study can be achieved by triangulating the findings using qualitative data through interviews with managers from organizations practicing open innovation.

III. References

- Alexy, O., George, G., & Salter, A. J. (2013). Cui bono? The selective revealing of knowledge and its implications for innovative activity. *Academy of Management Review*, 38(2), 270-291.
- Argote, L. (1982). Input uncertainty and organizational coordination in hospital emergency units. *Administrative Science Quarterly*, 420-434.
- Armenakis, A. A., & Bedeian, A. G. (1999). Organizational change: A review of theory and research in the 1990s. *Journal of Management*, 25(3), 293-315.
- Balaneji, S.G., Turkyilmaz, A., Temizer, L., & Bulak, M.E. (2013). Analysis of open innovation systems. Management, Knowledge and Learning International Conference. June 19-21. Zadar, Croatia. Downloaded on March 23, 2015 from <http://www.toknowpress.net/ISBN/978-961-6914-02-4/papers/ML13-313.pdf>
- Barney, J. B. (1986). Strategic factor markets: Expectations, luck, and business strategy. *Management Science*, 32(10), 1231-1241.
- Becker, M. C. (2004). Organizational routines: a review of the literature. *Industrial and Corporate Change*, 13(4), 643-678.
- Bessant, J., Alexander, A., Tsekouras, G., Rush, H., & Lamming, R. (2012). Developing innovation capability through learning networks. *Journal of Economic Geography*, 12(5), 1087-1112.
- Boscherini, L., Chiaroni, D., Chiesa, V., & Frattini, F. (2010). How to use pilot projects to implement Open Innovation. *International Journal of Innovation Management*, 14(06), 1065-1097.
- Boscherini, L., Chiaroni, D., Chiesa, V., & Frattini, F. (2013). The process of organizational change in open innovation: evidence from high tech firms. *International Journal of Entrepreneurship and Innovation Management*, 17(1), 177-205.
- Buganza, T., Chiaroni, D., Colombo, G., & Frattini, F. (2011). Organizational implications of open innovation: an analysis of inter-industry patterns. *International Journal of Innovation Management*, 15(02), 423-455.
- Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science*, 52(1), 68-82.
- Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business Press.
- Chesbrough, H. (2013). *Open business models: How to thrive in the new innovation landscape*. Harvard Business Press.
- Chiaroni, D., Chiesa, V., & Frattini, F. (2010). Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. *R&D Management*, 40(3), 222-245.

- Chiaroni, D., Chiesa, V., & Frattini, F. (2011). The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm. *Technovation*, 31(1), 34-43.
- Christensen, J. F., Olesen, M. H., & Kjær, J. S. (2005). The industrial dynamics of Open Innovation—Evidence from the transformation of consumer electronics. *Research Policy*, 34(10), 1533-1549.
- Clark, C. E., Cavanaugh, N. C., Brown, C. V., & Sambamurthy, V. (1997). Building change-readiness capabilities in the IS organization: insights from the Bell Atlantic experience. *MIS Quarterly*, 425-455.
- Clausen, T. H. (2013). External knowledge sourcing from innovation cooperation and the role of absorptive capacity: empirical evidence from Norway and Sweden. *Technology Analysis & Strategic Management*, 25(1), 57-70.
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 128-152.
- Dahlander, L., & Wallin, M. W. (2006). A man on the inside: Unlocking communities as complementary assets. *Research Policy*, 35(8), 1243-1259.
- Diener, K., Luettgens, D., & Piller, F. T. (2015). Cost of Collaboration in Open Innovation: The Mediating Role of Search Strategy. Available at SSRN 2571558.
- Dittrich, K., & Duysters, G. (2007). Networking as a means to strategy change: The case of open innovation in mobile telephony. *Journal of Product Innovation Management*, 24(6), 510-521.
- Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Management*, 36(3), 333-346.
- Elsenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, 21(1), 1105-1121.
- Fauchart, E., & Von Hippel, E. (2008). Norms-based intellectual property systems: The case of French chefs. *Organization Science*, 19(2), 187-201.
- Felin, T., & Zenger, T. R. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy*, 43(5), 914-925.
- Felin, T., Foss, N. J., Heimeriks, K. H., & Madsen, T. L. (2012). Micro-foundations of routines and capabilities: Individuals, processes, and structure. *Journal of Management Studies*, 49(8), 1351-1374.
- Folta, T. B., & Leiblein, M. J. (1994, August). Technology acquisition and the choice of governance by established firms: insights from opinion theory in a multinomial logit model. In *Academy of Management Proceedings* (Vol. 1994, No. 1, pp. 27-31). Academy of Management.
- Foss, N. J., Laursen, K., & Pedersen, T. (2011). Linking customer interaction and innovation: the mediating role of new organizational practices. *Organization Science*, 22(4), 980-999.
- Fu, X. (2012). How does openness affect the importance of incentives for innovation? *Research Policy*, 41(3), 512-523.

- Galpin, T. J. (1996). *The human side of change: A practical guide to organization redesign*. San Francisco, CA: Jossey-Bass.
- Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management*, 40(3), 213-221.
- Gassmann, O., Sandmeier, P., & Wecht, C. H. (2006). Extreme customer innovation in the front-end: learning from a new software paradigm. *International Journal of Technology Management*, 33(1), 46-66.
- Gemünden, H. G., Salomo, S., & Hölzle, K. (2007). Role models for radical innovations in times of open innovation. *Creativity and Innovation Management*, 16(4), 408-421.
- Ghoshal, S., Korine, H., & Szulanski, G. (1994). Inter-unit communication in multinational corporations. *Management Science*, 40(1), 96-110.
- Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(S2), 109-122.
- Haour, G. (2003). *Resolving the innovation paradox: enhancing growth in technology companies*. Palgrave Macmillan.
- Hargadon, A., & Sutton, R. I. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly*, 716-749.
- Hausman, J., & McFadden, D. (1984). Specification tests for the multinomial logit model. *Econometrica: Journal of the Econometric Society*, 1219-1240.
- Heimeriks, K. H., & Duysters, G. (2007). Alliance capability as a mediator between experience and alliance performance: an empirical investigation into the alliance capability development process. *Journal of Management Studies*, 44(1), 25-49.
- Helfat, C. E. (1994). Firm-specificity in corporate applied R&D. *Organization Science*, 5(2), 173-184.
- Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 9-30.
- Hoopes, D. G., & Postrel, S. (1999). Shared knowledge, "glitches," and product development performance. *Strategic Management Journal*, 20(9), 837-865.
- Howell, J. M., Shea, C. M., & Higgins, C. A. (2005). Champions of product innovations: defining, developing, and validating a measure of champion behavior. *Journal of Business Venturing*, 20(5), 641-661.
- Huizingh, E. K. (2011). Open innovation: State of the art and future perspectives. *Technovation*, 31(1), 2-9.
- Huston, L., & Sakkab, N. (2006). Connect and develop. *Harvard Business Review*, 84(3), 58-66.
- Jacobides, M. G., & Billinger, S. (2006). Designing the boundaries of the firm: From "make, buy, or ally" to the dynamic benefits of vertical architecture. *Organization Science*, 17(2), 249-261.
- Jeppesen, L. B., & Lakhani, K. R. (2010). Marginality and problem-solving effectiveness in broadcast search. *Organization Science*, 21(5), 1016-1033.

- Judson, A. S. (1991). *Changing behavior in organizations: Minimizing resistance to change*. B. Blackwell.
- Kirschbaum, R. (2005). Open innovation in practice. *Research-Technology Management*, 48(4), 24-28.
- Kogut, B., & Zander, U. (1993). Knowledge of the firm and the evolutionary theory of the multinational corporation. *Journal of International Business Studies*, 625-645.
- Kotter, J. P. (1995). Leading change: Why transformation efforts fail. *Harvard Business Review*, 73(2), 59-67.
- Lakhani, K. R., Jeppesen, L. B., Lohse, P. A., & Panetta, J. A. (2007). The value of openness in scientific problem solving. Division of Research, Harvard Business School.
- Lakhani, K. R., & Jeppesen, L. B. (2007). R&D: Getting unusual suspects to solve R&D puzzles. *Harvard Business Review*, 85(5), 30-32.
- Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, 27(2), 131-150.
- Laursen, K., & Salter, A. J. (2014). The paradox of openness: Appropriability, external search and collaboration. *Research Policy*, 43(5), 867-878.
- Lewin, A. Y., Massini, S., & Peeters, C. (2011). Microfoundations of internal and external absorptive capacity routines. *Organization Science*, 22(1), 81-98.
- Lewin, K., (1947). Frontiers in group dynamics. *Human Relations*, 1, 5–41.
- Li, Y., & Vanhaverbeke, W. (2009). The effects of inter-industry and country difference in supplier relationships on pioneering innovations. *Technovation*, 29(12), 843-858.
- Lichtenthaler, U., Hoegl, M., & Muethel, M. (2011). Is your company ready for open innovation? *MIT Sloan Management Review*, 53(1), 45-48.
- Lichtenthaler, E. (2003). Third generation management of technology intelligence processes. *R&D Management*, 33(4), 361-375.
- Lichtenthaler, U., & Ernst, H. (2008). Intermediary services in the markets for technology: organizational antecedents and performance consequences. *Organization Studies*, 29(7), 1003-1035.
- Lichtenthaler, U., & Lichtenthaler, E. (2009). A capability-based framework for open innovation: Complementing absorptive capacity. *Journal of Management Studies*, 46(8), 1315-1338.
- Lim, J. N., Schultmann, F., & Ofori, G. (2010). Tailoring competitive advantages derived from innovation to the needs of construction firms. *Journal of Construction Engineering and Management*, 136(5), 568-580.
- Lin, X., & Germain, R. (2003). Organizational structure, context, customer orientation, and performance: lessons from Chinese state-owned enterprises. *Strategic Management Journal*, 24(11), 1131-1151.

- Lüttgens, D., Antons, D., Pollok, P., & Piller, F. T. (2012). Implementing open innovation beyond the pilot stage: barriers and organizational interventions. RWTH-TIM Working Paper, October.
- Lüttgens, D., Pollok, P., Antons, D., & Piller, F. (2014). Wisdom of the crowd and capabilities of a few: internal success factors of crowdsourcing for innovation. *Journal of Business Economics*, 84(3), 339-374.
- March, J. G., Schulz, M., & Zhou, X. (2000). *The dynamics of rules: Change in written organizational codes*. Stanford University Press.
- Martinez, M. G. (Ed.). (2013). *Open innovation in the food and beverage industry*. Elsevier.
- Minbaeva, D., Pedersen, T., Björkman, I., Fey, C. F., & Park, H. J. (2003). MNC knowledge transfer, subsidiary absorptive capacity, and HRM. *Journal of International Business Studies*, 34(6), 586-599.
- Mortara, L., & Minshall, T. (2011). How do large multinational companies implement open innovation? *Technovation*, 31(10), 586-597.
- Nieto, M. J., & Santamaría, L. (2007). The importance of diverse collaborative networks for the novelty of product innovation. *Technovation*, 27(6), 367-377.
- Perkmann, M. (2009, August). Trading off revealing and appropriating in drug discovery: the role of trusted intermediaries. In *Academy of Management Proceedings* (Vol. 2009, No. 1, pp. 1-6). Academy of Management.
- Perkmann, M., & Schildt, H. (2014). Open data partnerships between firms and universities: The role of boundary organizations. *Research Policy*, 44(5), 1133-1143.
- Piller, F. (2010). Open innovation and intermediaries: facilitating knowledge transfer. Available at: http://archive.euussciencetechnology.eu/uploads/docs/Piller_Open_Innovation-Wien_BILAT-event.pdf
- Rohrbeck, R. (2006, August). Technology scouting—harnessing a network of experts for competitive advantage. In 4th Seminar on Project and Innovation, Turku, Finland (pp. 15-29).
- Rohrbeck, R. (2010). Harnessing a network of experts for competitive advantage: technology scouting in the ICT industry. *R&D Management*, 40(2), 169-180.
- Roijakkers, N., Zynga, A., & Bishop, C. (2014). Getting help from innomediaries: what can innovators do to increase value in external knowledge searches? In Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.), *New Frontiers in Open Innovation*, Oxford: Oxford University Press, pp. 241-257.
- Romme, A. G. L., Zollo, M., & Berends, P. (2010). Dynamic capabilities, deliberate learning and environmental dynamism: a simulation model. *Industrial and Corporate Change*, 19(4), 1271-1299.
- Rothaermel, F. T., & Hess, A. M. (2007). Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. *Organization Science*, 18(6), 898-921.
- Roure, L. (2001). Product champion characteristics in France and Germany. *Human Relations*, 54(5), 663-682.

- Salge, T. O., Bohné, T. M., Farchi, T., & Piening, E. P. (2012). Harnessing the value of open innovation: The moderating role of innovation management. *International Journal of Innovation Management*, 16(03).
- Schiele, H. (2010). Early supplier integration: the dual role of purchasing in new product development. *R&D Management*, 40(2), 138-153.
- Sicotte, H., & Langley, A. (2000). Integration mechanisms and R&D project performance. *Journal of Engineering and Technology Management*, 17(1), 1-37.
- Sieg, J. H., Wallin, M. W., & Von Krogh, G. (2010). Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. *R&D Management*, 40(3), 281-291.
- Szulanski, G., Cappetta, R., & Jensen, R. J. (2004). When and how trustworthiness matters: Knowledge transfer and the moderating effect of causal ambiguity. *Organization Science*, 15(5), 600-613.
- Tao, J., & Magnotta, V. (2006). How Air Products and Chemicals" Identifies and Accelerates". *Research-Technology Management*, 49(5), 12.
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533.
- Van Den Bosch, F. A., Volberda, H. W., & De Boer, M. (1999). Coevolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organization Science*, 10(5), 551-568.
- Von Krogh, G., Nonaka, I., & Rechsteiner, L. (2012). Leadership in organizational knowledge creation: a review and framework. *Journal of Management Studies*, 49(1), 240-277.
- West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy*, 43(5), 805-811.
- West, J., & Bogers, M. (2014). Leveraging external sources of innovation: a review of research on open innovation. *Journal of Product Innovation Management*, 31(4), 814-831.
- Wilkins, A. L., & Ouchi, W. G. (1983). Efficient cultures: Exploring the relationship between culture and organizational performance. *Administrative Science Quarterly*, 468-481.
- Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, 27(2), 185-203.
- Zander, U., & Kogut, B. (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization Science*, 6(1), 76-92.
- Zeng, S. X., Xie, X. M., & Tam, C. M. (2010). Relationship between cooperation networks and innovation performance of SMEs. *Technovation*, 30(3), 181-194.
- Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 13(3), 339-351.

Appendix III.A1. Distribution of data samples.

	Total	Std. Error	[95% Conf. Interval]	
Organization				
Corporate	402	13.73	375.05	428.95
University	115	9.88	95.60	134.39
Consulting	108	9.63	89.10	126.90
Laboratories		6.51	32.22	57.80
Non-profit	38	6.01	26.20	49.80
Others	48	6.71	34.83	61.17
Industry				
Consumables	73	8.13	57.04	88.95
Biotechnology	70	7.97	54.34	85.65
Industrial	59	7.38	44.51	73.48
Chemical	50	6.83	36.57	63.42
Education	43	6.37	30.49	55.50
Electronics	40	6.15	27.90	52.09
Telecommunication	37	5.93	25.34	48.65
Food	36	5.85	24.49	47.50
Auto	32	5.53	21.12	42.87
Aviation and Aerospace	31	5.45	20.28	41.71
Materials	40	6.15	27.90	52.09
Utilities	21	4.52	12.12	29.87
Paper	18	4.19	9.76	26.23
Others	122	10.12	102.13	141.86
Region				
North America	177	11.65	154.12	199.87
Europe	184	11.80	160.82	207.17
Asia	52	6.96	38.33	65.66
South America	43	6.37	30.49	55.50
Africa	24	4.82	14.53	33.46
Others	276	13.24	249.99	302.00

Appendix III.A2. Correlation analysis.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29									
1. Int Pro																																						
2. Ext Net	0.22																																					
3. Interm	0.28	0.20																																				
4. Scouts	0.14	0.24	0.24																																			
5. Website	0.22	0.30	0.16	0.14	0.10																																	
6. Consort	0.66	0.16	0.35	0.24	0.18	0.21																																
7. Ext Cap	0.03	0.06	0.00	0.05	0.02	0.08	0.02																															
8. Corporate	0.05	-0.08	-0.01	-0.06	0.06	-0.01	0.06	-0.07																														
9. University	0.08	-0.05	0.08	-0.05	-0.03	0.08	0.08	0.07	-0.17																													
10. Consulting	-0.02	0.06	0.00	0.00	0.00	0.03	0.00	0.01	-0.10	-0.10																												
11. Lab	-0.00	-0.03	0.02	-0.07	0.04	-0.05	0.00	-0.05	-0.09	-0.09	-0.05																											
12. Non-profit	-0.01	0.05	0.00	0.07	0.00	0.00	0.00	-0.04	-0.12	-0.04	0.00	0.00																										
13. N. America	0.01	0.06	0.00	-0.01	0.05	0.10	-0.02	0.06	0.01	0.01	0.05	-0.03	-0.31																									
14. Europe	0.03	0.01	0.13	-0.02	0.00	-0.01	0.04	-0.06	-0.02	0.00	-0.04	0.05	-0.15	-0.15																								
15. Asia	-0.01	-0.05	-0.03	-0.09	0.01	-0.05	-0.02	0.00	0.02	0.14	-0.04	0.00	-0.10	-0.10	-0.04	-0.04																						
16. S. America	0.05	0.05	0.03	-0.03	0.07	0.06	0.08	0.00	0.20	0.10	0.14	0.03	-0.07	0.00	0.03	0.04	0.08																					
17. Africa	0.01	-0.04	0.12	0.10	0.00	-0.02	0.04	0.02	-0.08	0.03	-0.06	-0.07	0.02	0.04	-0.01	-0.02	-0.03	-0.11																				
18. Research	-0.03	0.04	-0.06	0.06	0.02	-0.05	0.02	-0.04	0.00	-0.07	0.00	0.05	0.06	-0.05	-0.03	-0.01	-0.05	-0.11	-0.01																			
19. Consum	-0.03	-0.04	0.00	-0.01	0.00	0.00	-0.10	-0.01	-0.06	-0.03	-0.01	-0.04	0.01	-0.02	-0.02	0.05	-0.02	-0.10	-0.09	-0.09																		
20. Biotech	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.00	-0.06	-0.03	0.06	-0.06	0.04	-0.02	0.01	0.00	-0.04	-0.09	-0.08	-0.08	-0.07																	
21. Industry	-0.05	-0.03	-0.04	-0.07	0.07	0.00	0.01	-0.08	0.29	-0.01	-0.03	0.17	-0.05	0.00	-0.02	-0.01	0.05	-0.08	-0.08	-0.07	-0.07	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
22. Chemical	-0.02	0.06	0.04	-0.01	-0.05	0.10	0.00	0.03	-0.08	-0.02	0.04	-0.02	0.00	0.08	0.00	-0.05	-0.04	-0.08	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
23. Education	-0.05	-0.06	-0.03	0.00	-0.03	0.00	-0.02	0.06	0.00	0.04	0.02	-0.05	0.00	-0.01	0.01	-0.02	0.06	-0.08	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
24. Electronics	-0.02	-0.02	0.00	-0.04	-0.08	-0.07	-0.04	0.03	-0.04	0.00	0.02	-0.05	-0.03	0.04	0.03	0.02	-0.04	-0.07	-0.07	-0.07	-0.07	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
25. Telecom	0.03	-0.03	0.03	0.07	-0.01	0.00	0.04	0.05	-0.05	-0.06	0.00	-0.04	0.00	0.06	-0.03	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
26. Food	0.14	0.01	0.01	0.09	0.02	0.04	0.12	0.08	0.13	-0.06	-0.02	-0.01	0.01	-0.07	-0.02	0.00	0.00	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
27. Automotive	0.00	0.02	-0.02	-0.05	-0.02	0.00	-0.05	-0.01	0.04	-0.07	-0.05	0.00	0.07	-0.03	0.02	-0.03	0.00	-0.08	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
28. Aerospace	0.02	-0.07	-0.03	0.05	-0.04	0.07	-0.02	0.01	-0.07	-0.06	-0.04	-0.03	-0.01	-0.02	-0.01	0.00	0.06	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
29. Material	0.02	-0.07	-0.03	0.05	-0.04	0.07	-0.02	0.01	-0.07	-0.06	-0.04	-0.03	-0.01	-0.02	-0.01	0.00	0.06	-0.05	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
30. Utility																																						

Notes: Int_Pro = Internal Processes; Ext_Net = Existing External Networks; Interm=Intermediary; Scouts=Tech Scouts; Website=External website; Consort=Consortia; Ext_Cap = External Capabilities; Consum=Consumables