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Jim Cheng

DOCTORAL DISSERTATION

Open Innovation Readiness: Large companies and their metrics and benchmarks for OI

Promoter: Prof. Dr Wim Vanhaverbeke

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Dedication

To my wife, Lindsay: Without your support and love, this thesis would never have existed. Love you bs.

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Chapter 1. Introduction

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1.1. Introduction

Open Innovation is a relatively recent concept in the field of management science and innovation management, but has become the focus of a rapidly growing body of literature in both academic research and industry practice. The term 'open innovation' was coined in 2003 by Henry Chesbrough, a professor at UC Berkeley. In open innovation, an organization uses both internal and external ideas, as well as internal and external paths to market to advance its technology (H. Chesbrough, 2003c). As the practice of open innovation has grown since 2003, companies and governments have increased and diversified their usage of open innovation as a framework to increase openness in research and development. Similarly, researchers have begun to address this paradigm from an academic standpoint.

As the use of and research into open innovation both grow, the field has begun to address open innovation readiness, in which a company or organization wishing to use open innovation assesses its ability to introduce and use this paradigm (H. Chesbrough & Crowther, 2006; Chiaroni, Chiesa, & Frattini, 2011; Wagner & Piller, 2012). Open innovation readiness assumes that there is sufficient knowledge on how open innovation works to be able to determine if future endeavors are on the correct path. As there have been more than 15 years of study and practice on the subject, I believe that there is enough evidence, in the form of studies, books, and experience, in both academic and industry settings, to correctly assess open innovation readiness.

A survey done by Chesbrough and Brunswicker (2013) shows that while more firms are adopting open innovation, there is still a lot of room to grow and improve OI practices and OI readiness. For example, formal OI practices such as written procedures and metrics are not frequently adopted, demonstrating that OI is still not fully institutionalized. Chesbrough and Brunswicker (2013) further report that while respondents are dissatisfied with OI metrics, they are somewhat happy with the results of their open innovation activities. This finding demonstrates flaws in OI metrics, in that they "failed to capture at least some of the perceived value from open innovation". In sum, this study demonstrates that OI readiness can certainly be improved.

Companies who practice open innovation still face problems implementing it when they lack OI readiness. Chesbrough and Brunswicker (2013) find that managing internal organizational change is the largest challenge reported by firms, followed by the management of the external innovation sources. These challenges seem to reflect that both the transition from closed to open innovation and the core of open innovation itself, namely the management of internal change and working with partners, are still not fully realized, leading to the lack of OI readiness.

Readiness is an important topic in the field of open innovation as it fundamentally supports and affects the transition to and implementation of OI. When they are not ready for the transition from closed to open innovation, companies waste valuable resources trying to correct problems such as internal organization changes, which could have been addressed much more easily and cheaply at the beginning of the process. As open innovation is essentially a people-driven paradigm, where building relationships and working together are paramount, moving to this way of working and thinking can be difficult for an organization. Preparing in advance of this change reduces the pain along this journey. Similarly, managing external innovation relationships is critical to OI success. An organization's ability to transition to a system in which external relationships are well-managed is fundamental. Open innovation readiness is an essential part of the open innovation process. An OI-ready company is better able to manage its journey to open innovation and save a lot of heartache, headache, time, and money.

This thesis, while certainly not comprehensive in its study on open innovation or open innovation readiness, will attempt to improve our understanding of how firms must be internally prepared as organizations to open up effectively to innovation partners. The purpose of this thesis is to inform the reader about how a company should organize itself to best implement and utilize open innovation; in other words, it defines, discusses, and explores the dimensions of open innovation readiness. Specifically, the research overall research question that this thesis would like to answer: What are ways that can demonstrate a company's readiness to participate in open innovation? A company that cannot demonstrate its OI readiness will most likely fail in its endeavor. As the study of OI readiness has not been studied or analyzed along specific traits, the scientific contribution of this thesis is the better understanding of this subject matter using specific lenses and angles.

1.2. Overall Structure

This thesis is not intended for solely an academic audience. While many papers have been written about this topic with the academic researcher in mind, this thesis is written for both open innovation researchers and practitioners. It is the view of the author that the field of managerial science should have practical and tangible components, allowing managers and practitioners in industry to easily understand and implement conclusions reached from academic research. Because of this, this thesis is broken up into several chapters, with two chapters intended for practitioners in industry and two chapters aimed at academic readers, with another chapter intended for both audiences. Chapters intended for the managers and practitioners have less academic jargon and fewer academic references, with more practical and concrete conclusions. This 'town and gown' division of the entire thesis allows for both kinds of readers to find use in this research.

Chapters 2 and 3 are written with the practitioner in mind, each focusing on a different topic, with chapter 3 having a decidedly more academic grounding. Chapters 4, 5, and 6 are based on a large survey of open innovation managers conducted specifically for this thesis. One (Chapter 4) reports analysis of this survey intended for practitioners, while the remaining two are written for an academic audience and employ more sophisticated research methodologies.

Additionally, each chapter in this thesis, with the exception of the introduction and the discussion/conclusion, is intended to be discrete and stand on its own, with its own research question. While a narrative thread runs through the entire thesis, each chapter is written as an individual paper or report with its own introduction, conclusion and references. This is due to both practical and philosophical reasons: the entire study of open innovation and its readiness is too broad and diverse for one thesis to cover. The paper structure of this thesis covers specific themes within the broad field. Each chapter pulls from different sets of data, or in the case of the three chapters based on the survey, different aspects of the data. As such, each develops different research questions and types of analysis.

As these chapters each explore specific themes and questions, this thesis does not provide or analyze an overarching systematic process of open innovation readiness. While many researchers or practitioners would expect such a comprehensive approach, the diversity of the research topics in this field and the variety of the data available make it difficult to integrate the different chapters as several parts that nicely build on each other as parts of a broader unifying theme. However, in the last chapter I bring the different research topics together to provide a general understanding of how open innovation readiness can help companies improve the effectiveness of their open innovation activities.

1.2.1 Open innovation global view

In order to define open innovation readiness, academics and practitioners require a global view of open innovation and an understanding of the successes and failures of its component parts. However, as stated above, it is not the goal of this thesis to provide such a comprehensive view, due to both the practical and philosophical approaches taken in this research. Those who would like to see how a global view of open innovation (and its readiness) could be structured can refer to an available model and toolkit (Bevis & Cole, 2018; Thierry, Waiyawuththanapoom, & Daneshgar, 2013), or look at the themes of the MOOI project. The MOOI project (Managing and Organizing Open Innovation) was started in 2013 by Professors Henry Chesbrough, Wim Vanhaverbeke, and Nadine Roijakkers, and is intended to be a comprehensive overview of open innovation specifically for practitioners, with practical and tangible actions that they can take within their organizations. The first phase of MOOI was a monthly video lecture, with each month discussing in detail a specific theme. Subsequent phases involve the development of a website and an e-book. The eleven themes of MOOI provide a good overview of the different themes in the complex topic of open innovation management. I list these eleven themes below:

Monthly themes for the MOOI project (H. Chesbrough, Vanhaverbeke, Roijakkers, & Cheng, 2013)

1. Aligning open innovation (open innovation) with corporate strategy
    a. How to derive open innovation objectives from a corporate strategy
    b. How to develop a corporate open innovation strategy and the practicalities of translating it to all levels of the organization
2. Role and actions of top management in supporting open innovation
    a. Support from top management
    b. Development of the right skills in the company
    c. Setting the objectives for open innovation in the company
    d. Open innovation managed from the Top or Bottom up?
3. How to set up organization, management, and communication structures supporting open innovation projects?
    a. How to set up general, company-wide good/best practice and knowledge management in support of open innovation?
    b. Processes required to implement open innovation effectively?
    c. Formal and informal organization to implement open innovation

    d. Centralized and decentralized ways of organizing open innovation?

4. How to recruit, select, train, etc. for open innovation: What skills, attitudes, personalities are needed?

    a. Reward systems and career paths
    b. Recruiting the right people and open innovation- skills training
    c. External and internal talent management
    d. HR department needs to redefine its role

5. How to create a corporate culture where open innovation can thrive?

    a. Corporate culture as a roadblock to open innovation
    b. Overcoming NIH / NSH syndromes?
    c. How to build an open innovation culture?
    d. Differentiation according to cultural archetypes

6. How to use IP strategically to accommodate open innovation?

    a. The role of the legal department?
    b. From a defensive role to a strategic partner in open innovation
    c. IP based business models as backbone for open innovation

7. How to change the R&D-department for open innovation?

    a. How to tighten the link with business and other functions?
    b. How to collaborate with external partners (technology partners, strategic suppliers, customers and crowds)?
    c. R&D subculture as hurdle / enabler to implement open innovation
    d. R&D personnel as problems solvers instead of solution providers

8. The open innovation implementation team

    a. Activities of the open innovation Team?
    b. Structure of the team?
    c. Which people to have on the team?

9. How to make effectively use of Innomediaries?

    a. Types of innomediaries
    b. What are the expected benefits? When to use them and when not?
    c. How to organize internally to work effectively with innomediaries?

10. How to evaluate the success of open innovation activities?

    a. What are the right KPIs?
    b. Appropriate metrics and reporting for open innovation
    c. Alignment of Finance department with open innovation strategy

11. Making it happen: From closed to open innovation

    a. How to start and sequence actions to implement open innovation?
    b. Phases and maturity in open innovation implementation
    c. How ready is a company to engage in open innovation?

These themes and sub-questions demonstrate the breadth of concerns, from hiring and structuring teams to measuring success of initiatives, involved in open innovation strategies, and demonstrate the importance of evaluating and establishing open innovation readiness prior to shifting to an open innovation approach.

1.3. Open Innovation Readiness

Closed innovation does not encourage the use of partnerships or cooperation, but emphasizes the role of companies' internal R&D in the development of new products. Previous organization structures that work in a closed innovation environment may not be compatible with open innovation, which is why preparation is key. Open innovation readiness, or becoming internally organized for open innovation, is an important preamble to using open innovation. The process of shifting and structuring internally does not happen automatically and is a deliberate effort that usually takes several years before a company achieves a satisfactory level of open innovation readiness.

The academic literature and the business press both contain a good deal of information about how open innovation works. They provide guidance on how to create partnerships, how to use tech transfer offices, and how to manage IP. In other words, there is a lot of information about the external facing tasks of an organization in open innovation. However, open innovation readiness is not only about outward facing activities, and in fact focuses much more on the internal structure and organization of a company, serving as a link between the activities of open innovation and the way open innovation is facilitated.

In order for a firm to shift from a closed to an open innovation paradigm, it must first make sure that its internal organization and structure will able to work in this new environment; in other words, it must build readiness for open innovation. The term 'Open Innovation Readiness' has been examined in the academic literature via a few case studies (Chiaroni, Chiesa, & Frattini, 2010; Chiaroni et al., 2011), along with a model and toolkit (Bevis & Cole, 2018; Thierry et al., 2013), and a similarly themed maturity model (Ellen Enkel, John Bell, & H. Hogenkamp, 2011a). However, these publications do not fully explore, from either academic or practitioner perspectives, how to be ready to work within an open innovation paradigm.

This lack of information on open innovation readiness, especially from a managerial or practitioner perspective, is one of the main driving forces for this thesis. As stated before, the goal of this thesis is not to fully explore all aspects of open innovation readiness, but rather to dig deeper into specific aspects. The ultimate goal is to contribute a much richer understanding of how firms must prepare themselves internally to reach great results with open innovation.

1.4. Introduction to the Individual Chapters

1.4.1 Review of metrics (Chapter 2)

Measuring general innovation is a widely discussed topic in both academic and business literature. Metrics are used in business to measure the strategy, input, progress, and output of a project. Simply put, they measure what you are doing, once you have planned it out and are executing it.

However, most metrics have been designed for a closed innovation organization, and these metrics are in many cases inaccurate when measuring an open innovation organization. The purpose of this chapter is to review the existing measurements and metrics for innovation to see how they should be adapted, or whether new metrics should be created specifically for open innovation. This chapter also categorizes and structures these metrics, which provides an interesting tool for managers, who now can see the full menu of the metrics available on order.

This analysis of the metrics for open innovation allows senior management to control and measure the open innovation activities in the company. Metrics guide pivots or changes, and can be integrated as part of reporting. Using these metrics will give management a detailed and objective view of open innovation. In order to see the positive effects of open innovation, managers need to measure how much the needle is moving over time and track whether the results are in line with the expected objectives. These metrics, once deployed and benchmarked, will be able to provide managers with how their company fares in its open innovation readiness, as they will be able to see how advanced they are in OI.

This chapter is essentially a literature review on innovation metrics for both academics and practitioners alike. It provides a structure and categorization for the metrics that allows for a fuller understanding of how they are placed along the open innovation process, and where they might be useful. This chapter responds to the questions raised in Theme 10 of the MOOI framework provided earlier.

1.4.2 LinkedIn analysis (Chapter 3)

This chapter is an analysis of the careers of open innovation practitioners on individual and aggregate levels. It is intended for human resource managers and senior level managers to help them to better understand the career paths and trajectories of open innovation professionals. The research question of this chapter relates most clearly to Theme 4 in the MOOI framework discussed above, and will help organizations think through building a team with the appropriate talent and experience in preparation for developing open innovation strategies. Similarly to chapter 2, by better understanding how advanced their company is with their OI workforce relative to similar companies, managers are able to see their level of OI readiness.

This chapter developed from an opportunistic research strategy, and uses LinkedIn as a valuable resource to view open innovation managers on an individual level. LinkedIn, a social networking site dedicated to professionals, is a huge database of individual professionals that lists their self-reported career and educational accomplishments. LinkedIn has never been used as a data source for open innovation practitioners, and I wanted to explore what this online data can reveal. This research provides insights into open innovation career development, including the past and future career paths of open innovation professionals.

As open innovation is ultimately a people-run operation that relies on various professionals and their relationships with each other, I wanted to learn more about the individual and focus on the human dimension of open innovation. The detailed, though self-reported, data from LinkedIn allowed me to generate the profile of an open innovation manager: her age, her tenure at the company, what department and function she came from, and where she went afterwards (company, function, department).

Analysis of these profiles shows that open innovation professionals tend to have a long average tenure within the same company (15 years), and they also stay in an open innovation function for a long time (7 years). Most open innovation publications focus on R&D departments, but I found that less than half (40%) of open innovation professionals came from a previous role in R&D role. The study also provides interesting insight about what happens after individuals leave open innovation positions. Most of them stay in the same company, but a significant minority becomes a consultant or moves to another company. More details can be found in the chapter.

This chapter is not intended to be an in-depth academic analysis of this topic, but it is rather a descriptive chapter with the business reader in mind. The intended business reader should be able to draw managerial implications from this chapter on career management for open innovation professionals.

1.4.3 Descriptives of survey (Chapter 4)

The primary data source for Chapters 4, 5, and 6 is a large survey on open innovation that was conducted among large companies. The purpose of this chapter is to provide a descriptive analysis of this survey to open innovation practitioners. By using the results of this survey as a benchmark, managers will be able to see how their company ranks on the multitude of aspects of open innovation, better understanding how they are in OI readiness.

The philosophy of the survey is that open innovation has both external and internal dimensions. Each dimension can be broken down further, into two blocks each, creating a four-block matrix. The external dimension represents the traditional and the more obvious practices of open innovation, where the company interacts with external parties. This dimension is divided into two blocks, Outside-In (or Inbound) and Inside-Out (or Outbound) open innovation. Outside-In practices of open innovation are the most commonly used and represent the situation where the company collaborates with partners to make use of their innovations, in order to strengthen its competitive position. Inside-Out is the opposite, where a company tries to monetize its internal innovations by searching for external paths to market. In this case, a company licenses or sells its technologies to (non-competing) external parties that can make use of them, or it spins off a technology project that is not strategically important for the company.

The internal dimension of open innovation focuses on the internal aspects of the organization; that is, the way a company has to be organized to conduct open innovation effectively. This dimension is less researched and understood. It can be further subdivided into two blocks, strategy and organization. Strategy refers to a company's vision of how to best use open innovation and how open innovation ties into the greater overall company strategy. Organization refers to how a company is internally structured in order to work effectively within an open innovation paradigm.

The survey explores the relationship between these four blocks (Outside-In, Inside-Out, Strategy, and Organization), and is organized with these blocks in mind. In Chapter 4 I develop a report for open innovation practitioners to help them better understand the link between these four blocks. I pay especially attention to the relationships between the two inward and outward dimensions.

As the survey was able to capture information from 160 respondents, it generates insight on a broad set of experiences with open innovation. Chapter 4 is divided into four large sections:

1. Open innovation adoption (length of open innovation usage, types of firms which adopt)
2. Open innovation partners and practices (types of open innovation partners, types of open innovation practices)

3. Internal organization for open innovation (impact of organizational factors on open innovation, impact of environment)
4. Value of open innovation (performance for open innovation vs non-open innovation firms, performance based on open innovation-usage intensity)

Each of these sections goes into detail on the most relevant topics for open innovation practitioners, including insights on the factors leading to the success of open innovation strategies, and best practices in open innovation. The link between the internal and external dimensions is a key underlying theme to this survey and is therefore explored in detail. In reporting the broad results of the survey, this chapter engages with a number of themes in the MOOI framework that deals with implementation and organizational strategies.

1.4.4 Two academic chapters (Chapters 5 and 6)

While based on the same large survey that was described in Chapter 4, Chapters 5 and 6 are different in tone, methods, and output. The intended reader for these chapters is not the open innovation practitioner, but rather an academic audience. Therefore, these chapters employ more sophisticated research methods and place survey results in the context of academic literature. Both of these chapters can give guidance to both managers and academics as to what an ideal practice can be within specific open innovation processes. This allows them to understand a company's OI readiness along these specific practices.

While many papers have measured the impact of open innovation (Du, Leten, & Vanhaverbeke, 2014; Greco, Grimaldi, & Cricelli, 2016), very few have the advantage of using data designed to specifically capture the complexity of the relationship between the external and internal dimensions, which, as described above, is one of the major reasons the survey was developed. This set of data allowed me to analyze open innovation in ways that were previously not possible, as the summary of two below papers shows.

1.4.4.1 Open innovation training: The key link between entrepreneurial culture, open innovation support, and firm openness (Chapter 5)

This chapter looks to analyze the relationships between internal organizational structure and culture (which we call organizational antecedents) and the likelihood that firms engage in outside-in open innovation activities. We break down these organizational antecedents as three independent variables: entrepreneurial orientation, open innovation support and open innovation training. There is a literature stream showing a strong link between entrepreneurial orientation and firms' openness (Gagne and Deci, 2005; Foss et al., 2011, 2013; Ind, Iglesias and Markovic, 2017; Keh, Nguyen, and Ng, 2007). However, merely giving flexibility and freedom to the employees to take entrepreneurial actions is not sufficient to ensure they will work effectively with external partners. They need active support within the company (Chesbrough, 2006; Salter and Criscuolo and Ter Wal, 2014) and they develop open innovation skills though training to cope with the challenges that they face in interacting with their partners (Salter et al., 2014; Chiaroni et al., 2011). Open innovation support and training have a direct positive effect on innovation performance, but we thus also assume that they are positively related to entrepreneurial orientation. The question becomes whether open innovation support and training mediate the effect of entrepreneurial orientation on the innovation performance of companies.

What we find is that entrepreneurial orientation has a significant positive effect on innovation performance when not accounting in the effect of open innovation support and training. However, once these two variables are introduced into the regression, the coefficient of entrepreneurial orientation is no longer significant. This indicates that open innovation support and training fully mediate the effect and that there is no direct impact of entrepreneurial orientation on a firm's openness. This agrees with some publications (Ian & Gregory, 2012) but contradicts others (Alegre & Chiva, 2013). As stated before, previous research into this topic did not have the ability to explore the complexity of relationships between variables as this chapter of the thesis does. The more detailed picture developed via the questionnaire gives a better insight into the relationship between entrepreneurial orientation and innovation performance, allowing critique of the results of previous publications. The questions addressed in this chapter relate most clearly to Theme 5 in the MOOI framework, but also speak to issues raised by Theme 3.

1.4.4.2 How does outside-in open innovation influence innovation performance? Analyzing the mediating roles of knowledge sharing and innovation strategy (Chapter 6)

Like the previous chapter, Chapter 6 is intended for an academic audience. In this case, the dependent variable is the innovation performance of a firm, with outside-in open innovation, knowledge sharing and innovation strategy as the independent variables. We discover a complex relationship between these factors, indicating that a simple direct relationship between open innovation and innovation performance is not accurate. Rather, the mediating impact of a company's internal structure,, represented by knowledge sharing and innovation strategy, is crucial to understanding how open innovation will help in innovation performance. In exploring the role of internal structure, this chapter engages with Themes 6 and 7 in the MOOI framework.

While empirical studies have been done before (Hung & Chou, 2013; Matthias & Andrea, 2011), they typically did not have the detailed insight into the internal structure of companies that is provided in this study, sometimes leading to misunderstandings about the impact of open innovation on innovation performance or about the conditions under which open innovation can improve innovation performance. As such, previously researchers have probably overemphasized the role of open innovation (the external dimension) on innovation performance. In essence, we find in this chapter that the relationship between inbound open innovation and innovation performance is fully mediated by the internal organization of the company. In other words, a company should be organized internally in a specific way in order for open innovation to improve innovation performance. Open innovation is effective only if the company is properly organized internally.

1.4.5 Conclusion and discussion chapter

The last chapter of this thesis is the conclusion and discussion, where I discuss the results from the previous chapters and develop a broader discussion reflecting on the main findings about open innovation readiness. More specifically, I discuss concrete factors in the organization of internal activities that will improve a company's open innovation readiness and ultimately improve open innovation and innovation performance, which will tie back into the overall open innovation framework. Additionally, I will relate the findings in each individual chapter to the global view framework to better contextualize how each of them speaks to open innovation as a whole.

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Chapter 2.

Measuring Open Innovation: Implications for Open Innovation Managers

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2.1 Introduction

An immense amount of text has been published about innovation within private and public enterprises. In today's world of necessary growth and sustainability, innovation has been hailed as the answer to providing both. Many articles published in academic, business, and popular press have studied how companies can become more innovative, promising growth against the disruptive effects of emerging technologies, empowered customers, new market entrants, shorter product life cycles, geopolitical instability, and market globalization (Muller, Välikangas, & Merlyn, 2005). Much of this literature on innovation describes how success is heavily dependent on how a company's management organizes its innovative process (Adams, Bessant, & Phelps, 2006).

Quantifying, evaluating, and benchmarking innovation are complex operations for companies (Adams et al., 2006; Frenkel, Maital, & Grupp, 2000); however, they are necessary to monitor and optimize innovation activities (Drongelen, Nixon, & Pearson, 2000). The theory and practice of innovation have advanced into paradigms such as open innovation, but innovation metrics have not kept pace. Yet, advancements in open innovation need to be measured properly to understand the progress companies are making or to check whether projects deliver the intended results.

Open innovation was first coined in 2003 to describe the paradigm in innovation management in which a company could employ external sources for its own use and could also put out its own internally produced resources for external use (Chesbrough, 2003). Open innovation has been growing in popularity; 500 articles on the topic had been published in top academic journals by 2013 (Podmetina, Fiegenbaum, Teplov, & Albats, 2014). Case studies were the primary study methodology in the early years of open innovation (H. Chesbrough, 2003b), whereas now open innovation has been studied using various methods, such as surveys, interviews, deeper case studies, and simulations (Podmetina et al., 2014). As the study of open innovation has advanced in both academia and in industry, quantifiable measurements are needed to evaluate efforts into open innovation. Open innovation practitioners need quantifiable proof that the company's investments into open innovation practices are paying off and are a correct investment of the company's resources. Additionally, the activities of this relatively young and untested practice of open innovation, such as the financial, innovation and project effectiveness impacts need to be reported to senior management. Academics, likewise, are interested in quantifying the effects of open innovation. While the study of innovation in general does include measurements, these existing metrics were appropriate in a closed innovation era and are not wholly suitable for use when firms are practicing open innovation.

Open innovation has become more prominent and practices have matured since its introduction, but metrics are needed to show to various stakeholders the effect of open innovation within the company and its network of suppliers, customers, and community. However, this demand for metrics, when viewed collectively, is idiosyncratic. Some who demand metrics are not clear on the definition and usage of open innovation. Others desire to measure only some aspects of open innovation, leaving other important aspects untouched. Many companies requesting metrics are at different maturity levels, sizes or industries, making benchmarking or selecting appropriate metrics difficult.

The purpose of this chapter is three-fold: 1) to create a detailed framework in which to categorize the various aspects of open innovation metrics using existing research on innovation in general and open innovation in particular; 2) discuss briefly the subsections within the framework and existing metrics for innovation and open innovation; 3) add new open innovation metrics to the subsections which are lacking. For the purposes of clarity within this chapter, the term innovation will be split into two parts. Open innovation describes the concept and related issues as first introduced by Chesbrough, while closed innovation refers to the concept of innovation used when a company performing R&D and other innovative activities only or mainly internally.

2.2 Innovation Metrics

2.2.1 Importance of metrics for innovation

It has been shown that practitioners see a strong need for and place importance on innovation metrics (Edison, bin Ali, & Torkar, 2013; James, Knut, David, Harold, & Andrew, 2008). According to a Boston Consulting Group survey, 74% of senior executives agree that innovation should be measured as rigorously as the company’s core businesses, but only 43% of companies actually do so (James et al., 2008). One major issue is the lack of innovation metrics itself, leading to under-measurement, measuring the wrong thing, or no measurement at all (James et al., 2008). This lack of the proper tools that practitioners can use to measure the innovation process needs to be addressed. One problem is that articles on innovation written for practitioners’ use remain disconnected from academic writing (Crossan & Apaydin, 2010), as the academic literature contains many theoretical or little-used innovation metrics that never make it across into the hands and minds of practitioners.

Another problem is a lack of faith in existing metrics. Critics of measurement for R&D, a major component of innovation, have described it as a "dubious art" that leaves behind unsatisfied managers (Werner & Souder, 1997). However, the relative newness of metrics for innovation may be the reason for this. As the field matures (Werner & Souder, 1997), metrics will become more usable and appropriate.

Ideally, metrics for innovation should be comprehensive, in that they should demonstrate the effectiveness of the innovation process overall as well as the effectiveness of its individual parts. These measurements, in turn, would allow managers and researchers to quantify the innovation process, make reports to the stakeholders, and make changes as necessary to improve the process.

Both the academic and professional literature discuss the need, design, and applicability of metrics to measure innovation. However, there has been little unity, coherence, or consensus to these studies, and as a result, innovation metrics are idiosyncratic, and in the case of academic literature, based more on the whims of the researcher and availability of data rather than to an overarching theory (Adams et al., 2006; Jensen & Webster, 2009). There are many frameworks or models in which to conceptually organize innovation metrics, ranging from linear models to feedback/feed forward loops; however, these are limited in many ways, from reasons such as having no consensus on the innovation process and having no way to account for the factors that may influence the implementation of innovation processes (Adams et al., 2006). To describe existing innovation metrics and how they measure the innovation process in parts and in its entirety, a simple overarching structure is necessary on which to hang each individual metric in order to form a coherent whole.

Using the well-known open innovation funnel (H. Chesbrough, 2006a) as a guideline, and in consultation with the many articles about innovation structures, this chapter will use the basic categories of "Activities", "Internal" and "Output", as the major headings under which to categorize innovation metrics (Erkens, Wosch, Piller, & Luttgens, 2014; PWC, 2011). Activities are the open innovation activities, such as outside-in or inside-out collaborations with different types of partners, "internal" stands for organizational culture and management structure and "output" is focusing on "hard" innovation metrics, such as sales of new product and the financial return on innovative activities, but it also includes 'softer' figures such as open innovation maturity. It should be noted that these sections are not clear cut, as there will be metrics that combine measurements from different sections, such as when comparing costs (activities) with patent counts (output). In addition, some metrics bleed into each other simply due to the fact that open innovation is not a linear process, so imposing a linear order will result in some overlaps.

2.2.2 Limitations of existing open innovation metrics

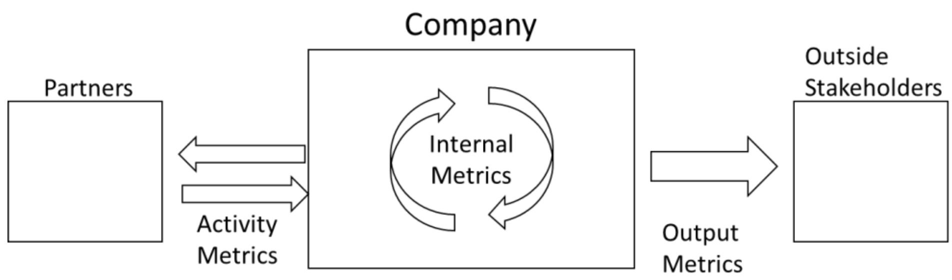
In a recent survey on open innovation, there was general dissatisfaction with the existing open innovation metrics available (H. Chesbrough & Brunswicker, 2013). The respondents felt that the existing metrics were not 'getting it right' nor were they helping to improve their OI activities. The current measurements used for closed innovation leave gaps because they do not adequately measure the entire open innovation process. Practitioners and researchers must tackle these gaps in measurement for open innovation.

One example of the way traditional metrics developed for closed innovation are no longer applicable to open innovation is the measure of research and development (R&D) expenditures. In a closed innovation environment, when all R&D is performed internally, such a measure is an easy and effective input measure, especially when used in combination with other metrics to create ratios, such as R&D over sales. However, in an open innovation environment, all innovation efforts are not reflected in R&D expenditures as a metric, as the firm's partners also have R&D spending. This spending benefits the partnership but is not accounted for by the internal R&D of the focal firm. A company can spend less on R&D and receive the same or even greater benefit due to its partnerships. Therefore, the accuracy of the R&D expenditures metric is not comparable between closed and open innovation environments. Additionally, a drop or increase in such a measure is not necessarily a good or bad thing in an open innovation context.

Only a few articles address metrics specifically for open innovation, but academic literature in this area has been slowly growing (Podmetina et al., 2014). One problem faced by the literature is that while open innovation is increasingly studied and practiced, the concept itself is not standardized (such as with the Total Quality Management initiative). Companies use the pieces of open innovation which are appropriate for their use and ignore the rest. The same applies to academics, who usually focus on only one aspect of open innovation. Without a standard model for open innovation, there can be no unified scales or metrics. The metrics which are either in use by practitioners or are written about in literature are idiosyncratic. However, one of the goals of this chapter is to move towards a standard model, allowing for benchmarking of open innovation metrics.

One of the steps that this paper takes in OI metrics is their categorization. We have created three major categories: Activity, Internal, and Output. Activity metrics are those which measure the open innovation activity, such as with outside-in or inside-out actions. Internal metrics are often less tangible, and measure things such as culture and management structure. Output is related to many 'hard' innovation metrics, such as sales of new products or financial figures related to innovation activities, but it also includes 'softer' figures such as open innovation maturity. Figure 2.1 visually lays out these three categories and how they relate to a company's open innovation process. Throughout this paper, examples of metrics will be shown in tables as they are discussed. The entire list of metrics can be found in the appendix at the end of this chapter.

Figure 2.1. OI metrics categorization



The academic literature has defined two methodologies for collecting data for open innovation metrics: one derived from existing datasets such as the European Community Innovation Survey (CIS) and one that uses primary sources, mostly surveys, to collect data specifically for the study (Podmetina et al., 2014). This chapter focuses exclusively on metrics from primary sources, as the intention is to define metrics that managers can use within their own companies. Secondary sources, many coming from broad and general surveys, are often inappropriate for use within a company or industry.

2.3 Activity Metrics

Activity metrics measure activities or resources that enter or exit a company during the innovation process, especially through innovation partnerships. They are intended to measure activities such as employee compensation as a percentage of innovative activity. When specifically applied to open innovation, they measure the outside-in and inside-out processes, loosely defined as when companies insource and/or outsource ideas, research, and people. These outside-in and inside-out processes deliver results on projects for internal or external use, working with partners such as suppliers, universities, or other companies.

As the vast majority of research into innovation has been based on closed innovation, we use these metrics as a starting point for our analysis. The academic literature usually takes R&D expenditures and the derivatives or ratios of expenditures as the primary activity indicators (Adams et al., 2006; Hagedoorn & Cloodt, 2003). These indicators, while easy to obtain, do not accurately measure the innovativeness of a company because these specific measures are an imperfect measure of innovation activity (Adams et al., 2006; Bougrain & Haudeville, 2002). A company who spends massively on R&D relative to competitors is not necessarily the most innovative (Hagedoorn & Cloodt, 2003), as expenditure may not reflect the effectiveness of the innovative activities. Financial activity metrics must include issues such as the adequacy of funding for innovation projects (Adams et al., 2006). In the existing literature, non-financial inputs are poorly represented and also need to be addressed (Adams et al., 2006).

I created five subcategories under the "activity metrics" category (outside-in, inside-out, coupled sourcing, resources, and workforce). While these subcategories are designed to be used for categorizing metrics for open innovation, they may also be applied to many closed innovation processes. The three subcategories most currently relevant for open innovation are outside-in, inside-out and coupled sourcing (Gassmann & Enkel, 2004). They are the most researched and have become the basis of an open innovation framework. While these subcategories have been designed to organize open innovation activities, they have not been developed to conceptualize open innovation metrics. In this chapter, I use these categories to formulate open innovation metrics. The two other subcategories and their related metrics, resources and workforce, while relevant to both closed and open innovation, come mostly from the closed innovation processes and metrics and often relate to expenditures. These last two subcategories, while relevant to OI metrics, will be briefly discussed below but there are not many existing metrics for open innovation.

2.3.1 Outside-in

The outside-in process, also referred in the literature as Inbound open innovation, is the part of open innovation where companies take in external knowledge. This section has been written about at length (Dahlander & Gann, 2010; Gassmann & Enkel, 2004; Gassmann, Enkel, & Chesbrough, 2010; Granstrand, Bohlin, Oskarsson, & Sjöberg, 1992; Podmetina et al., 2014; van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). In this literature, three measurement approaches can be distinguished: measures of linkages between a company and external organizations, measures of the internal information gathering process, and measures of customer information contacts (Adams et al., 2006).

Linkage metrics are used to determine how much and at what capacity a company is working with external parties. Linkages are one of the main tenets of open innovation, but metrics for linkages are scattered. It has been suggested that the quality and diversity of linkages is an important factor in determining openness (Adams et al., 2006; Cebon, Newton, & Noble, 1999). Linkages are loosely measured by networking or simply by counting the number of collaborations, networks, and communities of a company (Asakawa, Nakamura, & Sawada, 2010; Bascavusoglu-Moreau, Mina, & Hughes, 2012; Podmetina et al., 2014).

Information gathering metrics are obtained primarily through analysis of formal ways of information gathering, such as project reviews and technical reports (Adams et al., 2006; Oliver, Dewberry, & Dostaler, 2000). Additional suggestions for measurements on information gathering include benchmarking against competitors (Adams et al., 2006; Cebon et al., 1999).

Metrics for customer information contacts employ similar logic as the linkages metrics described above and can rightfully be considered an offshoot. A series of metrics have been proposed to measure how companies use customers for information, including the adequacy of information and contact time (Adams et al., 2006; Atuahene-Gima, 1995; Lee, Son, & Lee, 1996; Miller & Friesen, 1982).

In open innovation, collaborating with suppliers and customers is a normal event. Prior to the introduction of open innovation, there were already ways to measure collaboration in the innovation process, for instance by looking at use of guest engineers, percentage of projects in cooperation with third parties, and the extent in which top level decision making is characterized by cross-functional discussions (Adams et al., 2006; Kerssens-van Drongelen & Bilderbeek, 1999; Maylor, 2001; Miller & Friesen, 1982).

While the metrics that are currently used for innovation already cover most aspects of outside-in, there are a few gaps, mostly because existing metrics have not kept up with advances in technology which are used to communicate with larger numbers of third parties in order to potentially collaborate with them. These newer metrics specifically designed for open innovation measure level of open source development, idea exchange via websites, or idea competitions (Bascavusoglu-Moreau et al., 2012; Wagner & Piller, 2012).

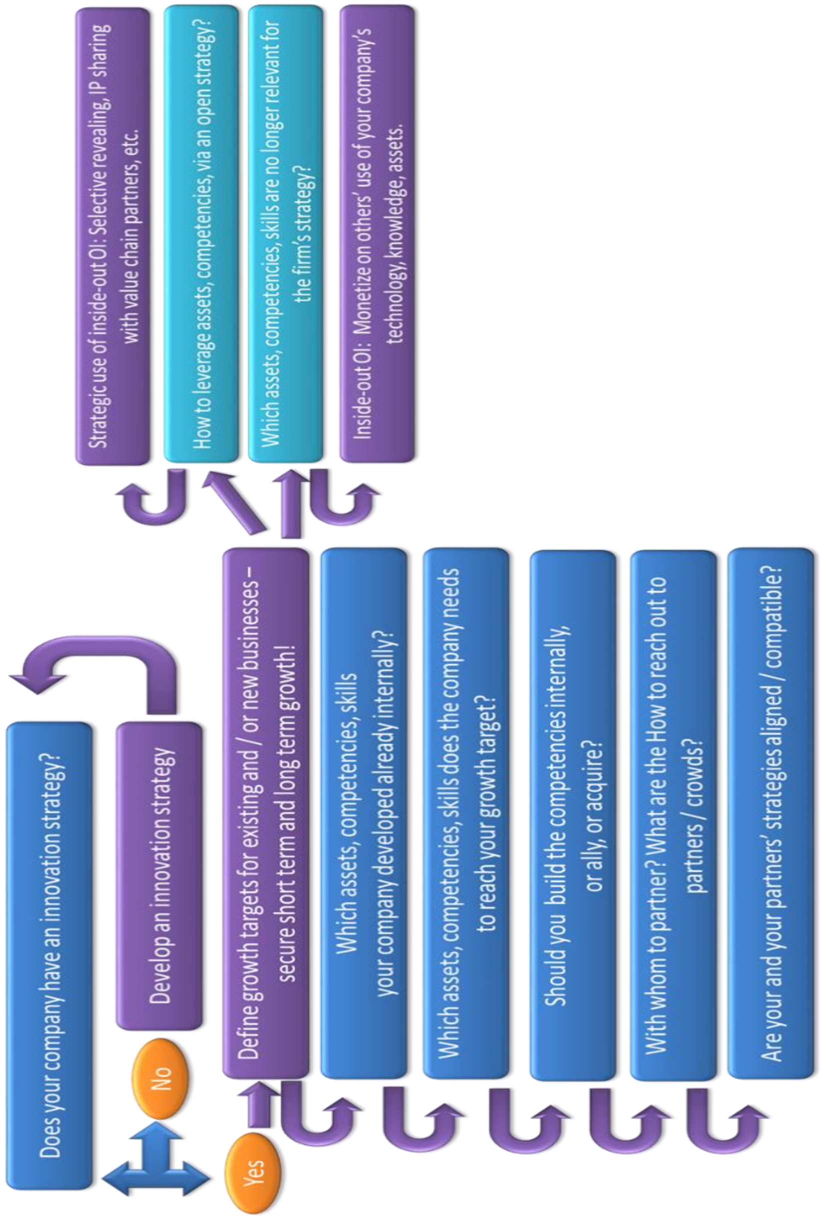
I propose some additional metrics beyond discussed in the literature and should be further developed within the context of outside-in open innovation are the level of use of corporate venture capital (CVC) to make equity investments in entrepreneurial ventures, and the use of information intermediaries who are tasked with speeding up and facilitating open innovation within a company. These newly created metrics are used in the survey that was created for this thesis.

Open innovation has been visualized as a funnel, which considers innovations as a pathway of the research-development-launch process (Chiaroni et al., 2011; Lazzarotti & Manzini, 2009; Vanhaverbeke, 2013). The phases in this process can be considered an early, medium or late stage project, respectively, and each entails different ways of working with partners. In the research phase, one can collaborate with universities; in development, one can use venture capital or take a part in licensing; in the launch phase, where the product is de-risked and ready for market, the technology can be acquired or the manufacturing or distribution rights negotiated. Metrics can certainly be used to measure the progress at each of these phases, depending on the needs and strategy of the organization.

If each stage or phase in open innovation has different requirements, depending on the project, then it is necessary to ask: what is the value or need in having many open innovation linkages or partnerships- Is there an optimal number? Is more always better? As described above, linkage metrics have been defined in the literature as a critical measure of open innovation processes. However, there are certainly downsides to having more linkages, such as taking up more managerial time and the risk of IP leakages. Additionally, is it better to have a few strong ties, many weak ties, or is there an optimal mix? While these questions cannot be answered in this chapter, building a diverse set of metrics will help a company decide what best supports their strategy.

Another model or process that might help a company evaluate their outside-in open innovation activities is the Need-Find-Get Want model (Slowinski & Sagal, 2010), which is a process model breaking down the process for bringing in needed technologies. This model has grown in popularity since its introduction, but as it takes into the account the overall strategy of the company, there is no one commonly used metric that measures how the company’s overall strategy is tied into its outside-in activities. Figure 2.2 below shows one model which can be used by managers to evaluate their open innovation activities (H. Chesbrough et al., 2013):

Figure 2.2: Model for open innovation activity evaluation



As most of the efforts within outside-in are measured quite comprehensively, these proposed metrics are very specific to certain open innovation processes. Table 2.1 shows outside-in metrics found in literature as well as what I have used in my survey to open innovation managers, which will be discussed in subsequent chapters.

Table 2.1: Outside-in metrics

1. Level of Engagement directly with lead users and early adopters (Bascavusoglu-Moreau et al., 2012)
2. Level of Open source development (Bascavusoglu-Moreau et al., 2012)
3. Idea exchange through websites, idea competitions (Bascavusoglu-Moreau et al., 2012; Wagner & Piller, 2012)
4. Setting up innovation networks and hubs with other firms (Bascavusoglu-Moreau et al., 2012)
5. Sharing facilities with other organizations, inventors, researchers, etc (Bascavusoglu-Moreau et al., 2012)
6. Licensing in externally developed technologies (Bascavusoglu-Moreau et al., 2012)
7. These outside-in questions below are from own survey
    a. We collaborate with customers on innovation projects.
    b. We include knowledge from suppliers in the development process
    c. My company/group cooperates with universities.
    d. My company uses corporate venture capital (CVC) to invest in external start-ups ("CVC: Equity investments by established corporations in entrepreneurial ventures"; "Startup: a company with a limited operating history- they are usually newly created
    e. My company/group uses crowdsourcing ("the act of taking a job that is traditionally performed by an employee and outsource it to an undefined, generally large group of people in the form of an open call")
    f. We use information intermediaries to find and use external ideas. ("Companies that help innovating companies to use external ideas more rapidly and to find markets where their own ideas can be used by others for mutual benefit")
    g. My company/group uses alliances to acquire additional knowledge.
    h. We use brainstorms and invite our entire network to join.
    i. My company/group licenses Intellectual Property (IP) from other companies.
    j. My company/group is open to license IP from beyond our industry
    k. We use a structured process when choosing our open innovation partners

2.3.2 Inside-out

The polar opposite of outside-in is inside-out, also known as Outbound open innovation. In this process, a company takes its internal knowledge and spins it out, usually in the form of selling or licensing patents or spinning out companies or ideas. Inside-out corporate activities and metrics to measure these activities are far fewer and occur less often when compared to outside-in (Athreye & Cantwell, 2007; Podmetina et al., 2014). However, this process remains an important part of open innovation and has been studied at both the operational and strategic levels by Lichtenthaler, who associates it with outbound technology transfers and situates it within the knowledge transfer framework (Granstrand et al., 1992; Lichtenthaler, 2007, 2009; Lichtenthaler & Ernst, 2008; Lichtenthaler & Lichtenthaler, 2010; Lichtenthaler & Muethel, 2012; Podmetina et al., 2014).

Inside-out processes are less often discussed in the literature on innovation, but are a fundamental concept for open innovation. There are a few existing metrics within the field of innovation that are relatable to inside-out. The current metrics measure the number of outsourced R&D projects or the number of patents sold or licensed (Bascavusoglu-Moreau et al., 2012). Proposed metrics for inside-out could be to measure the use of CVC to spin off companies, the openness in intellectual (IP) licensing to any takers, or a ‘use it or lose it’ strategy for speed in IP licensing. These open innovation-specific metrics for inside-out present a large gap in innovation measurements, and advancements in such measurements would make a large impact by forcing practitioners to consider using this process more.

One of the core reasons for doing inside-out is monetization. The ability to release underused technology from within your company and earn from it is certainly beneficial. On the other hand, outside-in is more about competitiveness and growth of a company's businesses. Because of this, financial measures are important for inside-out. There are various ways to conduct inside-out activities, and metrics to measure the financial value of these different approaches have different levels of difficulty. Licensing, for example, is one of the easiest measures of value to obtain, as the figures are quite apparent. On the other hand, spinoffs or spinouts are much more difficult to measure because the full value of such a venture is not realized until the exit. This causes uncertainty, especially if the vitality of the venture is in doubt. However, if a venture is performing well, there is no downside to the company, and there are various options to obtain a reasonable valuation of the spinoff.

Inside-out can be used as a strategic tool. For instance, in the strategy of free revealing a company reveals its internally developed technologies to the outside as a way to signal, for example when creating standards (Dahlander & Gann, 2010). Here specific measurements are difficult to come by, beyond measuring the strategy as a whole and whether it has achieved its desired aims. Additionally, the strategy of "non-fit" can be applied, which is so to say the opposite of the Need-Find-Get-Want model (Slowinski & Sagal, 2010) for outside-in open innovation. Here, technologies which do not fit into the overall strategy are expulsed (Lichtenthaler, 2008). This is similarly done with abandoned pharmaceutical compounds or in difficult financial times, where inside-out is used to shed assets (H. Chesbrough & Chen, 2015; H. W. Chesbrough & Garman, 2009). As with metrics for strategy, it would be difficult to get hard numbers other than number of technologies expulsed, but metrics would provide guidance and reporting.

Table 2.2 shows lists of metrics which were collected from the literature and includes metrics which were created specifically for a survey given to open innovation managers which will be discussed in later chapters.

Table 2.2: Inside-out metrics

1. Percentage of facilities shared with other organizations/ inventors/ researchers
2. Setting up innovation networks and hubs with other firms (Bascavusoglu-Moreau et al., 2012)
3. Sharing facilities with other organizations, inventors, researchers, etc (Bascavusoglu-Moreau et al., 2012)
4. Outsourcing R&D projects (Bascavusoglu-Moreau et al., 2012)
5. These inside-out questions are from our own survey
    a. My company/group uses external sales channels ("ways to put your product/service on the market via outside companies")
    b. My company/group uses corporate venture capital to create new companies out of underutilized technology.
    c. We use external venture capital to facilitate spin-offs ("Equity or equity-linked investments in young, privately held companies by groups of private investors")
    d. We license our Intellectual Property (IP) to other companies.
    e. We license our IP to everybody who wants to use our IP
    f. Our IP is protected via patents, copyright, and trademark and NOT trade secrets
    g. We license our IP as soon as we discover that we are not using it ("Use or Lose It" strategy)
    h. We work with information intermediaries to help sell/ distribute our IP
    i. We form alliances to exploit our knowledge#

2.3.3 Coupled sourcing

Coupled sourcing, also known as alliances and co-development, is the combination of Outside-In and Inside-out, where companies work together and give and take is crucial for success (Gassmann & Enkel, 2004). As metrics to measure coupled sourcing would simply combine metrics for outside-in and inside-out, few metrics specifically measuring coupled sourcing have been developed. One exception is a survey measuring the level of collaboration, specifically in knowledge sharing, between collaborating firms (Häussler, 2010; Podmetina et al., 2014). Measuring knowledge sharing specifically would be difficult, as measures of input or output of knowledge may hinder the free flow of information exchange and would require an agreement from all parties to contribute to the measurements. While even more difficult, it would be helpful to measure which of the knowledge being shared is relevant to the project or the balance of relevant knowledge that every party contributes. Many of the other proposed metrics presented above could also apply to coupled sourcing, such as the use of CVC, or an intermediary company. Table 2.3 show two additional proposed metrics used to measure coupled sourcing.

Additionally, the academic literature on alliance management loosely covers how to work with partners. Checklists on how to do so could be used to measure these partnerships (de Man & Roijakkers, 2009).

Table 2.3: Coupled-sourcing metrics

1. Joint R&D with other firms (Bascavusoglu-Moreau et al., 2012)
2. Joint university research or research labs

2.3.4 Resources

Companies also must figure out if they have allocated enough resources, in most cases capital and personnel time, for their open innovation projects. As discussed above, metrics such as R&D expenditures are prominent, as they are the easiest to measure and the most tangible (Adams et al., 2006). Some metrics are based on or derived from R&D expenditures, such as expenditures over total sales (Adams et al., 2006; Lichtenthaler, 2008). As many metrics within this subtopic are primarily related to funding, some simply tie funding into open innovation best practices, such as whether funding for innovation activities is adequate, or whether the company invests in certain departments or activities (PWC, 2011), as shown in Table 2.4. Metrics for open and closed innovation which fall under the Resources subcategory are prevalent within innovation metrics, as these are financial numbers which are easily understood. However, improved metrics for practitioners of open innovation would ask detailed questions to explore whether or not and in which way certain aspects of the open innovation process are funded sufficiently.

Table 2.4: Resources metrics

1. Funding to drive 'open' innovation? (PWC, 2011)
2. Stimulating 'open' innovation by providing adequate gap development funding? (PWC, 2011)
3. Support of a high performing technology transfer office? (PWC, 2011)

2.3.5 Workforce

Similar to resources metrics, workforce metrics are easily measurable and understood, as they measure the human resources aspect of the innovation process. Existing metrics have measured salaries or compensation in relation to total compensation, the number of innovation employees, or the number of innovation outsiders being used (Huston & Sakkab, 2006b; Kuczmarski, 2001), as shown in Table 2.5. Many workforce metrics are used for both closed and open innovation, such as checking the adequacy of staff numbers, compensation or even qualitative measurements, such as whether open innovation managers are well supported or whether certain open innovation professionals are experienced enough in performing certain actions (PWC, 2011). Another workforce measurement is the informal hours of R&D work that are hidden in other activities or take place outside of working hours (Adams et al., 2006; Kleinknecht, 1987).

These measurements provide managers with a more nuanced view of resources and workforce, but are coarse-grained instruments, as they do not exclusively nor particularly apply to the open innovation process. Similar to the argument made earlier with regards to R&D expenditures, traditional workforce metrics that are accurate in a closed innovation context are no longer useful in open environments, as open innovation partners contribute their own workforce to the project. So, while one company's workforce hours can be reduced in open innovation projects, the output can still be greater due to the additional hours from the partners. The total hours spent by a focal firm and its partners in a project may eventually be smaller / greater, indicating that open innovation would lead to (in)efficiencies compared to closed innovation. The closed innovation approach has a tight link between a focal firm's R&D expenditures and patents whereas this may not be true in open innovation.

Given these partnerships, measurements must be taken more holistically in an open innovation environment. Metrics must consider benefits, costs and efforts of all of the partners together, as individual cost allocations may be different than in a closed innovation environment. However, a holistic approach may face its own difficulties, such as partners not having the required information.

Table 2.5: Workforce metrics

1. Open innovation rewards for employees (as % of compensation) (Huston & Sakkab, 2006b; Kuczmarski, 2000)
2. Professionalization of TTO and / or licensing department
3. Extent of talent utilization coming from the outside

2.3.6 Other activity metrics

As the possibilities for open innovation activities is large, the ability to measure them is equally so. Table 2.6 lists metrics which could not definitively be placed in one of the other activity sections, but are placed in this table for completeness.

Table 2.6: Other Activity metrics

1. Investment in open innovation (% of overall innovation expenditures)
2. Number of open innovation dedicated staff (Vanhaverbeke survey)
3. Specific recruitments to implement open innovation approach
4. Number of involved departments in open innovation projects
5. Number of registered innovators in the collaborative platform
6. Quality of employees' involvement (number of ideas, contributions)
7. % of staff's objectives on the achievement of open innovation planned results

2.4 Internal Metrics

In both closed and open innovation, internal activities are the center of the process and usually the 'secret sauce' of a company's R&D efforts. Internal metrics are a significantly subtler and harder to develop set of metrics relative to the Activity metrics discussed above. These metrics measure the activities within a company and are softer than the hard numbers of financial and other quantifiable metrics. Data on internal activities are harder to collect and understand. Despite these challenges, a growing number of metrics have been proposed, and broader application in industry would have a strong impact.

I have created nine subcategories for internal activities, to reflect the large potential of this category and to allow for granularity in both metric creation and open innovation process design. The nine subcategories are: Knowledge Management, Innovation Strategy, Project Management, Organization and Culture, Services, In/Outreach, and Change Management. Many of these subcategories are derived from a review article on closed innovation (Adams et al., 2006). The processes, from which activities metrics can be derived, have the most impact on open innovation functions. As they have the fewest number of metrics, they represent the largest gap in the study of open innovation metrics.

2.4.1 Knowledge management

Knowledge Management is a company's ability to identify, acquire, and utilize external and internal knowledge (Adams et al., 2006). Knowledge Management has been shown to be a critical part of the innovation process (Adams et al., 2006; Hull, Coombs, & Peltu, 2000). Sub-subcategories of Knowledge Management include idea generation, absorptive capacity, and the management of implicit and explicit knowledge (Adams et al., 2006; Davis, 1998; Lichtenthaler & Lichtenthaler, 2009a).

Idea generation metrics attempt to count the number of ideas generated by a company This is sometimes known as inventive capacity (Lichtenthaler & Lichtenthaler, 2009a) or the extent to which a company uses different tools and techniques for idea generation (Adams et al., 2006; Chiesa & Masella, 1996).

Absorptive capacity is the ability of a firm to accumulate knowledge, specifically "an ability to recognize the value of new, external knowledge, assimilate it, and apply it to commercial ends" W. M. Cohen and D. A. Levinthal (1990, p. 128) (Adams et al., 2006; Alexy, West, Klapper, & Reitzig; W. M. Cohen & D. A. Levinthal, 1990; David J. Teece, 2010). Higher levels of absorptive capacity are positively related to innovation and performance (Adams et al., 2006; C.-J. Chen, 2004). An extension of absorptive capacity is the concept of tacit knowledge, where knowledge is unconsciously or semi-unconsciously held in an individual or group's mind (Leonard & Sensiper, 1998). Tacit knowledge is by nature very difficult to measure and does not appear to be well captured by existing metrics (Adams et al., 2006). The most concrete suggestion is to take the difference between market value and net book value to indicate the organizational value of intangible knowledge assets. However, even this indicator does not clearly define how much of this value can be attributed to innovation (Adams et al., 2006; Sveiby, 1997). More recent studies have asked qualitative questions about three different levels of knowledge integration within a company: domain specific, procedural, and general (Frishammar, Lichtenthaler, & Rundquist, 2012).

For open innovation in particular, R&D intensity, or the measure of R&D expenditure relative to sales, would be a very raw measure of absorptive capacity (Laursen and Salter, 2006). In addition, the retention capability, or the number of alliances which are dormant, or the number of active and inactive partners over five years, are all very rough measures of absorptive capacity (Lev, 2000). These metrics raise a practical question: under what conditions can the relevant figures be generated? Some of them can be created via surveys or interviews, but the difficultly lies in collecting the data to employ these metrics.

2.4.2 Communication

In open innovation, communication between all stakeholders is naturally very important. It has been demonstrated that there is a positive relationship between internal communication and innovation, as measured by number of committees and number of meetings and contacts (Adams et al., 2006; Damanpour, 1991). To measure external communications, metrics focus on whether communication is taking place, how intensively, and with whom (Adams et al., 2006; Cebon et al., 1999; Lee et al., 1996; Rothwell, 1992; Souitaris, 2002). Internal and external communication can be measured through evaluations (subjective) or counts (objective) (Adams et al., 2006). Subjective measures include questions such as: 'we always consult suppliers/customers on new product ideas' (Parthasarthy & Hammond, 2002) and 'degree of organization members involved and participating in extra-organizational professional activities' (Damanpour, 1991). Objective counts include 'extent of communication amongst organizational units or groups measured by various integrating mechanisms such as numbers of committees and frequency of meetings' (Anderson & West, 1998), 'frequency of formal meetings concerning new ideas' (Souitaris, 2002), 'how well do the technical and finance people communicate with one another' (Szakonyi, 1994).

However, there is not much evidence that communication metrics are much used in practice. As discussed previously, it can be difficult to collect information from partners. As open innovation is based on partnerships, communication metrics, which evaluate the actual links between partners should have information from all parties, which may be difficult or unreliable.

While these metrics are not limited to open innovation, very little research has been conducted on open innovation communication metrics, with the (minor) exception of Lindegaard (2010). In his book, Lindegaard (2010) briefly talks about communication strategies for open innovation. A few of his actionable items can be converted to metrics, to verify the existence of best practices in this area. Items such as "people need to know where to go and how to get there" and top managers should "actively communicate about the importance of your open innovation effort and their strong support for it" (Lindegaard, 2010) are questions which can be used to measure a company's communication efforts.

2.4.3 Innovation strategy

Innovation Strategy is defined as "a timed sequence of internally consistent and conditional resource allocation decisions that are designed to fulfill an organization's objectives" (Ramanujam & Mensch, 1985), with management needing to take conscious decisions with regards to innovation goals (Adams et al., 2006; Sundbo, 1997). The literature on innovation strategy tends to focus on new product and market development plans; however, activities which are internally focused, such as new management techniques are seldom taken into account (Adams et al., 2006; B. b. Dyer & Song, 1998). For managers, it is important to note that the difference between intended strategy and what actually occurs will be smaller if the strategy is embedded in the culture of the company and behaviors of employees (Adams et al., 2006; O'Brien, 2003).

There are two types of innovation strategy measures in the literature: those that measure whether the company has an innovation strategy and those that consider strategy as a dynamic process that shapes innovation in the company (Adams et al., 2006). Measuring whether a company has an innovation strategy, while seemingly simple, can be done in multiple ways. Measurements can look for an explicit expression (does the organization have an innovation strategy?) or a commitment to differentiated funding for innovation efforts (Adams et al., 2006; Miller & Friesen, 1982; White, 2002). The measurements for a dynamic strategy assume that the strategy already exists and asks about its effectiveness in shaping and guiding. These metrics ask questions such as 'are structures and systems aligned' and 'do innovation goals match strategic objectives' (Adams et al., 2006; Bessant, 2003; Tipping & Zeffren, 1995).

In the case of open innovation, companies can use the above metrics to measure strategy. However, a simpler way to measure open innovation and strategy would be to ask if the open innovation activities fit into the overall strategy of the company. The question to be considered is the following: 'Does open innovation find and use what is needed by the company (outside-in) and can the company effectively identify what is not needed (inside-out)?'

As strategy is set by the upper management, few metrics in the literature consider leadership beyond the question of whether leadership is involved in innovation, which can be asked by measuring commitment or levels of concern (Adams et al., 2006; Chiesa & Masella, 1996; Coughlan, Chiesa, & Voss, 1994). While attention has focused on leadership in the context of the need for the commitment of top leadership to open innovation (Lindegaard, 2010; Mortara & Minshall, 2011), few leadership metrics have been defined in the literature.

2.4.4 Project management

Project Management covers the processes that require inputs and produce a marketable innovation (Adams et al., 2006). The innovation process is very complex; some events need to occur consecutively and others in parallel, with an efficient process being critical to innovation success (Adams et al., 2006; Globe, Levy, & Schwartz, 1973). Numerous approaches have been proposed to model innovation processes: as a series of events, as a social interaction, as a series of transactions, and as a process of communication (Adams et al., 2006; Farrukh, Phaal, & Probert, 2000; Nelson & Winter, 1982; Voss, Chase, & Roth, 1999; Zaltman, Duncan, & Holbek, 1973). While there is debate on how to model this process, there are a number of common aspects, including project efficiency, tools, communications, and collaboration (Adams et al., 2006).

Project management efficiency is measured in different ways, mostly through comparisons between budget and actual expenditure, or through speed (performance against schedule or duration of process), as innovation speed has been positively correlated with product quality (Adams et al., 2006; Cebon et al., 1999; Chiesa & Masella, 1996; Hauser & Zettelmeyer, 1997). Formal processes for innovation have been established, notably the stage-gate process, as well as the phased development, product and Cycle-time Excellence and Total Design

(Adams et al., 2006; R. G. Cooper, 1990; Jenkins, Forbes, Durrani, & Banerjee, 1997). All of these processes have in common the setup of structured stages in which go/ no-go deliberations either continue or end a project must be held (Adams et al., 2006). It should be noted that these structures and metrics are less applicable to the service industry, public or not-for-public sector innovations (Adams et al., 2006).

Due to the use of partners in an open innovation environment, many metrics could be adapted to estimate the impact of partners in project management. While many of the above metrics take into account interactions with external partners, the expanded pool of potential and actual partners is not fully accounted for and creates a large gap in measurements in this area. This missing information also makes it challenging to determine whether a project is successful or failed. In order to avoid problems with partners, an OI project needs to have an agreement upfront on KPIs and what to do if they if these metrics are met or unmet.

2.4.5 Organization and culture

Many of the metrics focusing on the innovative aspects in the organization and culture of a company come from the view that more innovative companies have different organizational approaches than less innovative companies (Adams et al., 2006). Numerous studies on the organization and culture of innovative companies have shown that work environments can promote or hinder innovation (Adams et al., 2006; Mathisen & Einarsen, 2004). A range of generic characteristics has been proposed for a project group focusing on an innovation task: multi-disciplinarity, dedicated project leader, inter-functional communication and co-operation, qualifications and the know-how of the project leader, team autonomy and the responsibility for the process (Adams et al., 2006; Ernst, 2002). While many of these traits are repeated throughout the literature, very few metrics have been proposed to measure them (Adams et al., 2006). Very few studies and a few metrics have addressed the flexibility of certain aspects of a company, such as organizational and production flexibility, resource allocation, and personnel (Adams et al., 2006; Coughlan et al., 1994; Ekvall, 1996; Lee et al., 1996).

As open innovation requires a different organizational culture compared to closed innovation, I expect that the measurement of an appropriate organizational culture will require highlighting different aspects than those previously emphasized by the literature. As the transition to open innovation requires much effort (Rus, Vanhaverbeke, & Cheng, 2015) to cultivate a different culture, many of the metrics for a closed innovation culture cannot be used or need to be modified. In fact, there are very few metrics with which to measure open innovation culture. I suggest that some of the metrics from the Activities section can be used to indirectly measure culture, for example, the ones measuring ideas exchanging, cooperation with other parties, and quality of employee involvement. These metrics would provide an insight into the culture of an organization, as the presence of these activities would be a proxy to the maturity of its open innovation culture.

Metrics have been developed to measure organizational climates that are supportive of the innovative process, namely the Team Climate Inventory (TCI) and the KEYS instrument for assessing the work environment for creativity (Adams et al., 2006; T. M. Amabile, Conti, & Coon, 1996; Anderson & West, 1998; Mathisen & Einarsen, 2004; Mathisen, Einarsen, Jørstad, & Brønnick, 2004). The

TCI is based on four main factors: participative safety (the participative nature of the team in decision making and how secure do individual members feel in proposing things), support for innovation (amount of practical support for innovation versus the amount of professed support by the senior management), vision (the clarity, definition, shared-ness, attainability and value of the team's objectives and vision), and task orientation (the team's willingness to reach the highest possible standards of task performance) (Adams et al., 2006; Anderson & West, 1998).

Individual and group autonomy in the innovation process is very important (Adams et al., 2006; T. Amabile & Khaire, 2008). Metrics for autonomy are varied: 'the degree of freedom personnel have in day-to-day operating decisions such as when to work and how to solve job problems, including freedom from constant evaluation and close supervision' or 'percent- age of R&D portfolio with explicit business unit and/or corporate business management sign-off' (Abbey & Dickson, 1983; Adams et al., 2006; Tipping & Zeffren, 1995). Other proposed metrics about autonomy include 'freedom to make operating decisions' and 'degree of empowerment' (Abbey & Dickson, 1983; Adams et al., 2006; Tipping & Zeffren, 1995).

Motivation metrics range in scale from a focus on individuals, to groups, to the entire company. Individual motivation can be measured by 'the extent to which personnel is well rewarded' while group motivation can be measured by 'our reward system is more group-based than individual-based'. Levels of motivation at the company level can be revealed by 'the degree to which the organization attempts to excel' (Abbey & Dickson, 1983; Adams et al., 2006; Parthasarthy & Hammond, 2002).

A shared and clear vision has been said to make innovation more effective (Adams et al., 2006; Patterson & West, 2005). In the Team Climate Inventory, vision is broken into sub-dimensions such as clarity, shared-ness, attainability and value (Adams et al., 2006; Anderson & West, 1998; M. A. West & Anderson, 1996). It has been found that that only factor which has predictive power over the potential for success on all aspects of an innovation process is having a clearly stated mission and vision (Pinto & Prescott, 1988). M.A. West (1990) refines this by adding that the quality of innovation is partly a function of vision.

Open innovation literature often sees the culture of a company as the main inhibitor to accepting open innovation. In particular, the 'Not Invented Here' (NIH) and 'Not Sold Here' (NSH) syndromes refer to a situation in which a company has developed a culture of resistance to outside ideas and sales (H. Chesbrough, 2003b; H. Chesbrough, Vanhaverbeke, & West, 2006a; Dahlander & Gann, 2010; Elmquist, Fredberg, & Ollila, 2009; Gassmann, 2006; Katz & Allen, 1982; Keupp & Gassmann, 2009; Lichtenthaler & Ernst, 2006; Remneland-Wikhamn & Wikhamn, 2011). Metrics to measure NIH and NSH are difficult, and the ones that currently exist simply ask employees and managers if NIH or NSH exists and to what degree (Remneland-Wikhamn & Wikhamn, 2011; Tranekjer & Knudsen, 2012).

The culture metrics discussed above and listed in Table 2.7 are based on existing studies of culture but do not fully capture something the complicated nature of culture in an open innovation environment. An approach which can be used as a basis for future open innovation culture metrics comes from a list of cultural barriers to open innovation adoption (Rus et al., 2015). Barriers include: Lack of commitment from top management, Rigid-top down approach, Lack of transparency, Lack of focus on value generated from open innovation, Knowledge-hoarding & silo-working, Not-invented-here syndrome, Not-sold-here syndrome, Negative attitude towards risk-taking and failure, Distinct departmental subcultures, Lack of capability, Incentive misalignment. This listing, while not exhaustive, provides a framework with which to develop metrics on open innovation culture.

Table 2.7: Culture metrics

1. Innovation and Flexibility
2. New ideas are readily accepted here (Patterson & West, 2005)
3. The organization is quick to respond when changes need to be made (Patterson & West, 2005; Remneland-Wikhamn & Wikhamn, 2011)
4. Management here are quick to spot the need to do things differently (Patterson & West, 2005; Remneland-Wikhamn & Wikhamn, 2011)
5. This organization is very flexible; it can quickly change procedures to meet new conditions and solve new problems as they arise
6. Assistance in developing new ideas is readily available
7. People in this organization are always searching for new ways of looking at problems

2.4.6 In/outreach services

Little has been written in either the academic or business literature on the support services within a company, including In/Outreach and its related metrics. Support services are services offered within a company which allow innovation to occur. Within open innovation, support services refer primarily to the Technology Transfer Office (TTO) or a similar group (such as the IP department), a department within the company responsible for the acquisition or sale of technology. One of the most prominent of these groups is the Philips IP&S team. Proposed metrics would measure the adequacy and strength of the TTO, the transparency of its processes, and the efficacy of its in and outreach (PWC, 2011).

Additional proposed metrics are listed in Table 2.8 and would also include the revenue generated from the monetization of technology, or its fit into open innovation and overall strategies.

Table 2.8: In/Outreach Services metrics

1. What services does the technology transfer office provide to researchers?
2. Is the TTO aligned with strategic goals of the company (which technology can be sold, which should be acquired)?
3. How active/strategic is the technology transfer office in reaching out to the internal and external communities?
4. How transparent are the processes, procedures, activities, and outcomes of the technology transfer office?

2.4.7 Change management

While less often applied to open innovation, Change Management is a large separate field of study. Change management is needed to move from a closed innovation to an open innovation system (Chiaroni et al., 2011). Few metrics measure change management in open innovation, and relevant ones should be drawn from other subtopics such as culture and project management, such as measuring company flexibility over the change management period. Additionally, the existing literature on open innovation maturity, including Abell, Felin, and Foss (2008) and Enkel, Bell and Hogenkamp (2011), defines structured levels of open innovation maturity which can be used as metrics to determine the change in open innovation maturity over time.

2.5 Output Metrics

Output metrics measure the end point of the innovation process, such as when the product or service is launched or when a patent is issued. These metrics, either in isolation or together with another metric, provide the basis for the bulk of the current metrics on open innovation. As with input metrics, their popularity is mostly due to the fact that they are easily obtainable and understandable figures. Table 2.9 lists a selection of output metrics collected for this thesis.

Table 2.9: Output metrics

1. Percentage of external ideas (of all ideas)
2. Percentage of projects achieved through open innovation
3. Percentage of new products/services launched with partners
4. Time to market with open innovation (vs other)
5. Percentage of patents/other IP rights through open innovation projects (of all patents)
6. Revenue generated by open innovation projects (vs other)
7. Number of open innovation success stories as % of all projects (and in comparison with closed innovation projects)
8. Open innovation budget allocation proportionate to profitability hotspots

2.5.1 Portfolio management

Portfolio management is the way a company manages its R&D portfolio in terms of making strategic, technological and resource choices (Adams et al., 2006; R. G. Cooper, Edgett, & Kleinschmidt, 1999). Success in managing this portfolio is a critical part of competitive advantage (Adams et al., 2006; Bard, Balachandra, & Kaufmann, 1988). In the end, the goal of portfolio management is to balance the competing priorities of maximizing returns while minimizing risk (Adams et al., 2006).

The selection process for evaluating projects and then allocating resources to them has been said to be most successful when it is systematic and has clear selection criteria (Adams et al., 2006; Hall & Nauda, 1990). The earliest evaluation methods used return on investment as the primary criterion (Adams et al., 2006; Bard et al., 1988). Subsequent models have used sophisticated mathematical algorithms and models, but have been ignored by industry possibly due to their complexity and their failure to account for organizational decisions and communication processes. More recent models have also taken into account qualitative factors in the decision processes (Adams et al., 2006; Schmidt & Freeland, 1992).

Models range from quantitative financial measures, such as internal rate of return, net present value, and return on investment, to qualitative metrics such as peer review and subjective measures of portfolio balance (Adams et al., 2006; R. G. Cooper, Edgett, & Kleinschmidt, 2001; Henriksen & Traynor, 1999). However, these metrics are not without their faults: quantitative measures require monitoring and data entry, while surveys do not show large usage (Adams et al., 2006; Hall & Nauda, 1990). It has been noted that the best companies use explicit and formal tools and constantly apply them to the portfolio, asking questions such as 'is it balanced in terms of quantity of short and long-term projects?' and 'is there a balance between high and low risk projects and large and small projects?' (Adams et al., 2006; Brenner, 1994; R. G. Cooper et al., 2001). Other methods for evaluating portfolio management ask if portfolio evaluation measures are formalized (Adams et al., 2006; Cebon et al., 1999; Chiesa & Masella, 1996), attempt to evaluate the level of proficiency of the organization's ability to evaluate and select projects (Adams et al., 2006; Szakonyi, 1994), or measure projects against their results and alignment with business objectives (Adams et al., 2006; Lee et al., 1996).

The stage-gate methodology is often used in open innovation processes to bring order to technology development (R. G. Cooper, 1990; Robert G. Cooper, 2008). New research further integrates stage-gate into open innovation and new product development. One example is Grönlund, Sjödin, and Frishammar (2010), who link these concepts but do not provide usable metrics. However, metrics do play an important role in the stage-gate methodology, as moving a project along through the various stages requires quantifiable milestones.

2.5.2 Patent counts

Many metrics in innovation take into account a specific form of output: patent counts, as in the number of patents used or obtained and the value of these patents (Adams et al., 2006). In the past, patent counts have been used to measure innovativeness; however, their value is not universal as patents have varying utility within organizations (Adams et al., 2006; Griliches, 1990). Within open innovation, counting patents becomes even less useful, as is the case with other metrics originally used for closed innovation, because of the role of partners. To be effective in open innovation, aggregate patent count should involve all the partners (also and their partners) and should be measured on a project level. However, companies have varying IP practices, from patenting all activities to patenting nothing at all. This uneven practice makes it difficult to standardize across all partners a metric using patent counts (as a measure for the level of innovativeness, for example). Moreover, measuring patents should be done on a project level, as different open innovation projects within a company inevitably use different partners. With open innovation projects, patents can be used in different ways. With inside-out OI, patents can be used for licensing or can be used to receive equity in spin-off companies.

2.5.3 Commercialization

Commercialization is the set of processes that make an innovation successful. It includes marketing, sales, distribution, and joint ventures (Adams et al., 2006). However, the literature does not provide many metrics for commercialization, possibly due to the idea that these activities fall within the realm of other specialists such as marketers rather than in the study of innovation (Adams et al., 2006; Hultink, Hart, Robben, & Griffin, 2000), yet the success of open innovation should in the end be measured in term of commercial successes. The few metrics for commercialization include numbers of products in a given period, organizational commitment, market analysis and monitoring, launch proficiency (sales force, distributional and promotional support), adherence to a commercialization schedule, and formal post-launch reviews (Adams et al., 2006; Atuahene-Gima, 1995; Balachandra & Brockhoff, 1995; Griffin, 1993; Song & Parry, 1996; Verhaeghe & Kfir, 2002; Zedtwitz, 2002). Notably, Proctor and Gamble, a large consumer goods company and a large proponent of open innovation, has a metric which measures the percentage of new products generated from external technology (Huston & Sakkab, 2006a).

2.6 Conclusion and Discussion

Metrics for innovation have been demonstrated to effectively drive positive change within an organization and are demanded by industry. While the field of open innovation is only fifteen years old, the study and practice of innovation more broadly is much older. While much can be learned from closed innovation metrics, closed innovation measures cannot always be applied to open innovation due to very different mindsets and ways of working. This chapter is not an exhaustive study in open innovation metrics, but it is written simply and clearly to inform open innovation managers about the consequences for measuring and monitoring open innovation once they decide to engage with external innovation partners.

One of the purposes of this chapter is to discover what metrics exist for innovation in general, in order to see what can be used specifically in the field of open innovation. The demand for open innovation metrics is growing as the practice of open innovation increases. As the paradigm shift from closed innovation to open innovation is significant, many of the existing metrics are ineffective. New metrics are required to measure these new areas, such as partner management, IP sharing, or retention capability. In addition, many of the existing closed innovation metrics should be heavily modified or removed as working with partners has changed how firms operate.

In particular, evaluating open innovation requires a holistic view which has not yet been fully introduced or developed in a company. One of the goals of this chapter is to provide a framework for managers to consider how they are running their open innovation activities, to see which points need to be improved, and to suggest suitable metrics to assist in the improvement process. Because OI spans organizational boundaries, open innovation will cause metrics to move away from firm level indicators. Therefore, we need to look for levels of analysis where the role of the firm and its partners can jointly be measured. That can be the project level or even the ecosystem level (usually in bigger projects). Evaluating these joint projects requires a focus on specific measurements in OI such as IP sharing and revenue distribution.

As open innovation metrics is a young field of study and practice, it remains open to valid critique. In terms of validity, there is insufficient evidence of success, especially with regards to the more popular measures of patent counts and R&D expenditures (Adams et al., 2006). Additionally, there is not much evidence that subjective perception metrics are actually linked to performance (i.e., whether the perception that 'We are good at X' reflects actual performance) (Adams et al., 2006).

This chapter has highlighted many theoretical and practical gaps in the available open innovation metrics. Notably, there are few metrics on the topics of knowledge management, open innovation strategy, commercialization, or culture, the 'middle part' of the innovation process (Adams et al., 2006; Cordero, 1990). As a side note, this chapter is meant to inventory and structure metrics for open innovation, providing an overview on OI related metrics whose intended audience are OI practitioners. We did not go into detail on the reliability and validity of this paper, as we felt the it is beyond the scope of this paper to test them one by one. While testing for reliability and validity is an interesting next step, our view is that by inventorying and then structuring them, we are critical of the metrics that we come across and only allow those that we think relevant into this chapter.

Additionally, currently available metrics rely too heavily on financial measures and codified knowledge, such as patents, as opposed to tacit knowledge (Adams et al., 2006). While hard numbers are the easiest to understand and obtain, they do not capture the full picture of a company's open innovation practices, and more focus should to be placed on the softer numbers. This inability to easily capture the complete picture of OI activities is a problem that will stay with OI perpetually.

Similarly, there are few more subjective measures that focus on the quality of people or conditions. Many metrics report the presence of certain people, positions, items, or leadership, but they do not measure directly their quality (Adams et al., 2006). While subjective measures are more difficult to obtain and measure, they usually provide a fine-grained view that, if developed and used properly, would fill a needed gap.

The metrics that currently exist lack also benchmarking and mutual alignment (Adams et al., 2006). These 'metrics of metrics' or comparing of similar metrics across companies and sectors, is seldom discussed. The lack of meta-metrics provides for further opportunities in research.

This research has a few key implications for managers. First, measuring and benchmarking open innovation is not an easy task. Using existing metrics is difficult in that most may not be appropriate for a particular situation. Modifying or creating new metrics is equally difficult. However, it is clear that metrics are necessary and may need to be developed in an idiosyncratic way. There should be a standardization of open innovation metrics, certainly within a company and its partners, but also across industries. This standardization will allow for a common language and terminology across different processes and activities, as well as for a codification of a specific logic for open innovation. This will allow for open innovation discussions to have a broader impact. This standardization should be simple to implement and easy to account for the flexibility inherent in implementing OI across businesses and industries. Ideally, such a standardization would measure the entire end-to-end open innovation process. As discussed above, while many of the metrics will be financial in nature, the ideal mix would include metrics on culture and other 'softer', non-financial metrics as well. As a practical matter, a standardization body should be established, much like other standardizations, which govern how and what should be measured in OI. When implementing and measuring these standardized metrics, the managers should be precise in their measurement, limiting the amount of subjectivity in the measurements. Which metrics should be standardized and how they should be implemented is beyond the scope of this paper, but would be an area of future study and action, of which should be how to establish such a standardization body. Most of the literature reviewed here is focused on the metrics, their structure, and the results of the measurements, but little has been reviewed on standardization.

It is also debatable if metrics are the right solution for OI practitioners, as newer methodology and frameworks such as balanced business scorecard, discovery driven planning, and OKRs are being used to control processes such as OI. I would argue that fundamental to controlling OI are metrics in that fundamental to all of the frameworks is an objective measure of how a piece of the process is performing. Metrics, aka, KPIs or KRs, will be that objective measure. A potential for future research would be to view how these metrics can be operationalized and governed in an organization, which would demonstrate how the above frameworks can take the underlying metrics and apply them to the company's strategy and goals.

This chapter provides a structure for which managers can frame their thinking on how their OI practice should be measured and also provides a list of actual metrics which can be used immediately and could even potentially be benchmarked against. The providing a metric framework and also giving examples is very practical for managers, essentially giving them a solid understanding and starting point for their OI metrics. This could lead to another potential chapter being written about how managers could very practically implement their OI measurement using the framework and metrics.

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Appendix

List of the most prominent examples within each category for open innovation metrics

1. Activity
    a. Outside-in
        i. Level of Engagement directly with lead users and early adopters (Bascavusoglu-Moreau et al., 2012)
        ii. Level of Open source development (Bascavusoglu-Moreau et al., 2012)
        iii. Idea exchange through websites, idea competitions (Bascavusoglu-Moreau et al., 2012; Wagner & Piller, 2012)
        iv. Setting up innovation networks and hubs with other firms (Bascavusoglu-Moreau et al., 2012)
        v. Sharing facilities with other organizations, inventors, researchers, etc (Bascavusoglu-Moreau et al., 2012)
        vi. Licensing in externally developed technologies (Bascavusoglu-Moreau et al., 2012)
        vii. These outside-in questions below are from own survey
            1. We collaborate with customers on innovation projects.
            2. We include knowledge from suppliers in the development process
            3. My company/group cooperates with universities.
            4. My company uses corporate venture capital (CVC) to invest in external start-ups ("CVC: Equity investments by established corporations in entrepreneurial ventures"; "Startup: a company with a limited operating history- they are usually newly created
            5. My company/group uses crowdsourcing ("the act of taking a job that is traditionally performed by an employee and outsource it to an undefined, generally large group of people in the form of an open call")
            6. We use information intermediaries to find and use external ideas. ("Companies that help innovating companies to use external ideas more rapidly and to find markets where their own ideas can be used by others for mutual benefit")
            7. My company/group uses alliances to acquire additional knowledge.

8. We use brainstorms and invite our entire network to join.

9. My company/group licenses Intellectual Property (IP) from other companies.

10. My company/group is open to license IP from beyond our industry

11. We use a structured process when choosing our open innovation partners

12. We have a structured open innovation partner selection process

b. Inside-out

i. Percentage of facilities shared with other organizations/ inventors/ researchers

ii. Setting up innovation networks and hubs with other firms (Bascavusoglu-Moreau et al., 2012)

iii. Sharing facilities with other organizations, inventors, researchers, etc (Bascavusoglu-Moreau et al., 2012)

iv. Outsourcing R&D projects (Bascavusoglu-Moreau et al., 2012)

v. These inside-out questions are from our own survey

1. My company/group uses external sales channels ("ways to put your product/service on the market via outside companies")

2. My company/group uses corporate venture capital to create new companies out of underutilized technology.

3. We use external venture capital to facilitate spin-offs ("Equity or equity-linked investments in young, privately held companies by groups of private investors")

4. We license our Intellectual Property (IP) to other companies.

5. We license our IP to everybody who wants to use our IP

6. Our IP is protected via patents, copyright, and trademark and NOT trade secrets

7. We license our IP as soon as we discover that we are not using it ("Use or Lose It" strategy)

8. We work with information intermediaries to help sell/ distribute our IP

9. We form alliances to exploit our knowledge

c. Coupled sourcing

i. Joint R&D with other firms (Bascavusoglu-Moreau et al., 2012)

ii. Joint university research or research labs

d. Resources
   i. Funding to drive 'open' innovation? (PWC, 2011)
   ii. Stimulating 'open' innovation by providing adequate gap development funding? (PWC, 2011)
   iii. Support of a high performing technology transfer office? (PWC, 2011)
e. Workforce
   i. open innovation rewards for employees (as % of compensation) (Huston & Sakkab, 2006b; Kuczmarski, 2000)
   ii. Professionalization of TTO and / or licensing department
   iii. Extent of talent utilization coming from the outside
f. Other
   i. Investment in open innovation (% of overall innovation expenditures)
   ii. Number of open innovation dedicated staff (Wim's survey)
   iii. Specific recruitments to implement open innovation approach
   iv. Number of involved departments in open innovation projects
   v. Number of registered innovators in the collaborative platform
   vi. Quality of employees' involvement (number of ideas, contributions)
   vii. % of staff's objectives on the achievement of open innovation planned results
   viii. Amount of open innovation rewards for employees

2. Internal
   a. Organizational Strategy (from own survey)
      i. My company/ group has a strong innovation strategy relative to competitors.
      ii. We innovate as fast as other companies.
      iii. Innovation is managed throughout the company/ group (ie, there is a formal planning process, C-level approval, budget cycle, review procedure, substantial number of people have innovation targets)
      iv. Both internal and external knowledge sharing takes place continuously and is well-supported by knowledge management processes.
      v. My company/ group has a clear view on how it wants to develop its product portfolio (ie, complete product roadmaps, identified areas to innovate, and necessary resources assigned)

vi. My company/ group evaluates innovation projects on false positives ("A R&D project that went entirely through the process, went to market through the company's business model and failed")
vii. My company/group evaluates innovation projects on false negatives ("A R&D project that does not fit in the company's business model, and is therefore not perceived as valuable to the firm but that becomes a success with another company's business model.")
viii. We always share our problems with all internal and external sources who are interested to solve the problems
ix. My company/group is effective in using external knowledge.
x. In my company/group, there are regular discussions as to whether people are working effectively together
xi. In my company/group, objectives are modified in light of changing circumstances

b. Many of these points below came from Adams, Bessant and Phelps (2006). Innovation Management Measurement: A review.
c. There are no specific open innovation metrics that could be found in the literature for many topics, which leaves a gap in the study of this topic. Metrics such as below are missing:
    i. open innovation and knowledge management
        1. Idea generation
        2. Knowledge repository
        3. Information flows
    ii. open innovation and Innovation Strategy
        1. Strategic orientation
        2. Strategic leadership
    iii. open innovation Project management
        1. Project efficiency
        2. Tools
        3. Communication
        4. Effectiveness of collaboration (Adams et al., 2006)
    iv. Organization and culture
        1. Culture
            a. Innovation and Flexibility
                i. New ideas are readily accepted here (Patterson & West, 2005)

ii. The organization is quick to respond when changes need to be made (Patterson & West, 2005; Remneland-Wikhamn & Wikhamn, 2011)

iii. Management here are quick to spot the need to do things differently (Patterson & West, 2005; Remneland-Wikhamn & Wikhamn, 2011)

iv. This organization is very flexible; it can quickly change procedures to meet new conditions and solve new problems as they arise

v. Assistance in developing new ideas is readily available

vi. People in this organization are always searching for new ways of looking at problems

b. Portfolio Management

c. Outward focus

i. This organization is quite inward looking; it does not concern itself with what is happening in the marketplace (Patterson & West, 2005; Remneland-Wikhamn & Wikhamn, 2011)

ii. This organization has difficulties to incorporate ideas coming from outside the organization (Patterson & West, 2005; Remneland-Wikhamn & Wikhamn, 2011)

d. Co-creation

i. This company builds products in conjunction with its customers and suppliers

2. These questions about Mindset are from our own survey

a. My company/ group supports Open Innovation principles within my organization.

b. My top management support the use of external ideas for Open Innovation.

c. My legal department supports Open Innovation.

d. My human resources department supports Open Innovation.

e. My company/ group shares internally developed ideas with external sources.

f. Corporate venture capital is managed well in my organization.

g. My company/ group manages alliances well.

h. There is a systematic training of people in open innovation.

i. There is a dedicated open innovation team within the company/ group.

j. "Not Invented Here Syndrome" does not exist in my company/ group (The syndrome that can be applied to companies who do not want to implement a technology that was not produced inside their company)

k. "Not Sold Here Syndrome" does not exist in my company/ group (The syndrome that can be applied to companies who do not want to sell a product/ technology that was not produced inside their company)

l. There is systematic knowledge sharing within my company/ group.

m. In my company/ group, the management allows and empowers employees to take initiative and be entrepreneurial

n. In my company/ group, employees are willing to take initiative and be entrepreneurial

o. My company/ group rewards Open Innovation activities

v. Services and in/outreach

1. What services does the technology transfer office provide to researchers?

2. Is the TTO aligned with strategic goals of the company (which technology can be sold, which should be acquired)?

3. How active/strategic is the technology transfer office in reaching out to the internal and external communities?

4. How transparent are the processes, procedures, activities, and outcomes of the technology transfer office?

vi. Change Management

1. open innovation Team

a. Culture

b. Evaluators

vii. Other (to change into relative terms)

1. Number of open innovation projects vs other projects

2. Number of new partners

3. Diversity of partners (type, localization…)

4. Number of active partnerships

5. Frequency of meetings with partners

6. Time to respond to new ideas/solutions

7. Number of new products/services developed with partners

8. % of implemented ideas from new partners

9. Extent of leadership involvement in open innovation initiatives

3. Output

a. Portfolio

i. Risk/return balance

ii. Optimization of tool use

b. Other

i. Percentage of external ideas (of all ideas)

ii. Percentage of projects achieved through open innovation

iii. Percentage of new products/services launched with partners

iv. Time to market with open innovation (vs other)

v. Percentage of patents/other IP rights through open innovation projects (of all patents)

vi. Revenue generated by open innovation projects (vs other)

vii. Number of open innovation success stories as % of all projects (and in comparison with closed innovation projects)

viii. open innovation budget allocation proportionate to profitability hotspots

c. Impact

i. Different from other Output measures as it focuses more on larger and softer results. This was not discussed in the chapter, as this was determined to be too broad and out of scope for this chapter. However, for completeness, these metrics are listed below along with the figure showing its placement in the entire OI process.

ii. Successes (from own survey)

1. In regards to innovation, my company/ group is more successful than three years ago.

2. In regards to innovation, my company/ group is more successful when compared to competitors.

3. I am satisfied with the current performance, in regards to innovation, within my company/ group.

iii. Institutional

1. How does success in technology transfer benefit the institution?

2. How stable are the revenue flows from licensing and royalty payments?

3. How engaged are researchers in research communities?

iv. Market

1. How does the marketplace view the company in terms of open innovation/innovativeness?

2. How does success in technology transfer benefit the external community (ie, patents, external research community)

v. Reasons for open innovation (from our own survey)

1. Shorten time to market

2. To provide a window to novel (experimental / untested) technology

3. As a means of tapping into new (proven) technologies

4. To explore new capabilities and business opportunities

5. To apply existing capabilities and IP in new business opportunities or markets

6. To share risks and costs of innovations

7. Cheaper to use open innovation than traditional ways of doing business

vi. Maturity level (from Enkel, Bell, Hogenkamp, 2011)

1. Where would you say your company/ group is in terms of maturity level for innovation climate?

a. little initiative taking; accidental opportunity spotting

b. verbal management support; informal success sharing; targets at lower levels; informal assessment; individual initiatives; arbitrary screening

c. written open innovation strategy; success sharing by management; targets based on strategy; assessment partly open innovation based; champions appointed; screening by champions
d. strategy encouraged by management; regulated success sharing; targets set and communicated; champions awarded based on open innovation targets; champions encourage initiative taking; scouts assigned
e. management "walks the walk"; strategic success sharing; continuous adjustment of targets; open innovation-based assessment; initiative taking in whole organization; wide focus on external opportunities

2. Where would you say your company/ group is in terms of maturity level for partnership capability?

a. Affection-based collaboration; arbitrary, one-off partnering, individual initiatives
b. few, informal, repeated partnerships; informal standardization, no plan; satisfy own organization; few, dominant forms; selection based on affection and experience; skills through experience
c. formal, low intense, short during partnerships; partial standardization; behavioural guidelines; diversity with few partners; previously used parties network; selection based on network experience; training through example setting
d. intensity, focus, endurance in partnerships; partnering tools used, clear ownership; management actively encourages satisfaction of partners; specific forms, diverse partners; diverse network expansion; strategy-based selection; training in partnering
e. variation intensity; both standardization and specification; satisfaction of partners monitored; diversity along value chain; inter-network linkages; selection criteria based on proactive strategy; sharing of partnership expertise

3. Where would you say your company/ group is in terms of maturity level for internal processes?

a. informal communication of initiatives; commitment based solely on friendships; knowledge not shared; individual absorption; no identification of results; protective legal and IP system

b. low level monitoring; limited sharing of facilities; reputation-based commitment; knowledge and information informally shared in team; results thrown 'over the wall'; strict IP and legal conditions

c. Centralized reporting; regular meetings; opening facilities; on demand budget for meeting commitments; occasional inter-department knowledge sharing; absorption of knowledge actively encouraged; manager monitors progress; trust-based IP and legal attitude

d. linking initiatives; communication via intranet; start-up shared facilities; structural budget; project owners facilitate intra-organizational knowledge sharing; start process monitoring of results; long-term view of legal and IP

e. internal and external information gathering; contacting via central position; network facilities; open innovation integrated in budget; knowledge accessible in database; knowledge exploited in products; monitoring process in place; win-win contract

vii. Access new capabilities

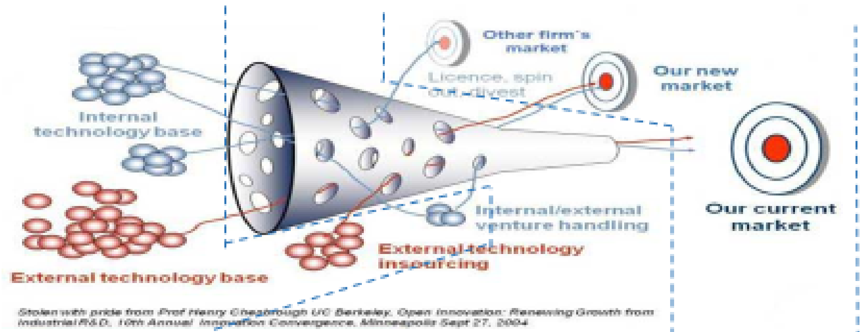
1. Revenue in new markets (Kuczmarski, 2000)

2. Growth rates in new markets

3. Market Share

4. Markets/Products per technology

5. Percentage of fresh footprint (total new product/service/business model) (Badani, 2009)



Inputs	Activities	Outputs	Impact
Outside-in: Setting up innovation networks and hubs with other firms	Knowledge Mgmt: Knowledge repository	Portfolio: Risk/Return Balance	Institutional: Engagement of researchers in research communities
Inside-out: Outsourcing R&D projects	Innovation Strategy: Strategic orientation w.r.t.	Other: Percentage of projects achieved through OI	Market: Marketplace view of the company in terms of OI/ innovativeness
Coupled sourcing: Joint R&D with other firms	Project Mgmt: Tools		Access New Markets: Revenue in new markets
Resources: Funding to drive Open Innovation	Organization & Culture: New ideas are readily accepted here		
Workforce: OI rewards for employees (as% of compensation)	Services: TTO alignment with strategic goals of company		
Other: Number of involved departments in OI projects	In/Outreach: Transparency of TTO		
	Change Mgmt: Culture of OI Team		
	Other: Number of OI projects vs other projects		

Chapter 3. What is the Profile of Open Innovation Managers in Large Firms?

Table of Contents for Chapter 3

Over the last fifteen years, open innovation has become a widely discussed phenomenon in both Europe and America (Chesbrough and Brunswicker, 2014). Companies use open innovation to gain a better understanding of new technological and market developments outside their organisation, combining these external capabilities with their own internal innovation resources. Open innovation enabled companies to benefit from new ideas, reduce risk, increase speed of innovation, and leverage scarce resources.

The benefits and potential risks of open innovation have been discussed in the literature on innovation management (Chesbrough et al., 2014; Salter et al., 2014). However, this discussion has been at the level innovation projects (e.g., Du, Leten and Vanhaverbeke 2014), or organizations (e.g., Chesbrough, 2003), or even ecosystems (Valkokari, Seppänen, Mäntylä and Jylhä-Ollila, 2017; Curley and Salmelin, 2018: Rohrbeck, Hölzle and Gemünden, 2009; Nätti, Hurmelinna-Laukkanen, Johnston, 2014; Furr & Shipilov, 2018). We know very little about the actual people who conduct open innovation activities in their organizations. There is virtually no information on the profile of managers who are leading or facilitating open innovation activities in large companies (exceptions du Chatenier et al., 2010; Golightly 2012; Mortara and Minshall, 2011; Podmetina et al. 2013; and Wagner and Piller, 2012). One could speculate that open innovation managers are different from other managers in that OI managers need to work with third parties on a regular basis, more so than ‘average’ manager. As OI relies on a trusted relationship between parties, it is up to these managers to form and maintain the bridge between their employer and the external partner. As such, these managers should have the trust and respect of their internal colleagues as well as their partners.

This gap in the literature is somewhat surprising, as several authors have been emphasizing the crucial role of open innovation managers and teams (Chiaroni et al., 2010, 2011; Mortara and Minshall, 2011; Huston and Sakkab, 2006; Pfister, Jack and Darwin, 2017). An increasing number of large companies have created *open innovation teams* and team members have specific tasks in driving open innovation (Mortara and Minshall, 2011). The tasks of these teams are multiple: train managers of the various services, protect scientists and researchers in their relations with other structures (companies, universities, laboratories), and develop new tools and processes (Golightly, 2012; Minshall et al., 2009). But a question remains: what is the profile of the managers of these teams?

The lack of empirical evidence about the profile of managers who operate in open innovation teams is a major barrier in understanding the mechanisms how open innovation is actually developed and conducted in companies. The recent shift towards interorganizational collaboration in innovation is the work of managers who are responsible for open innovation in their organizations. Although the work of these open innovation managers is crucial in understanding how firms organize their innovation activities internally and in collaboration with their technology partners. Success in open innovation stems from the way it is managed in companies and that is in turn the work of managers that have been dedicated to managing open innovation activities and processes. Taking this managers' point of view is an interesting lens to understand how firms can implement open innovation successfully. Therefore, in this study we focus on the following questions: What are the career implications? What is their background? How long do they stay in an open innovation job, and what is their tenure in the company?

Are they more or less likely to get promoted, if they work on open innovation? How long have they worked in the open innovation area? When they move to another functional responsibility, what is that function? Do these people remain in the same company, or do they leave to work in a new company? If they leave, do they still work in open innovation, or do they also move to another functional area?

We rely on queries in LinkedIn to discover the profile of open innovation managers. We identified managers in LinkedIn whose job is tightly related to open innovation. The rich information on the LinkedIn pages allows us to develop a detailed profile of open innovation managers. To our knowledge, this is the first time open innovation managers get portrayed and the profile that emerges from the data provides a benchmark for companies that are active in open innovation or intend to do so. The data also show that open innovation managers are on average for a considerable time working in that position, they come from different parts of the organization and most of them are promoted to other positions in the same company afterwards. A small minority set up their own consultancy activities afterwards and very few go and work for (competing) companies.

This study is organized as follows. In the next section we discuss how the study was set up based on LinkedIn profiles of open innovation managers. Next, we focus on the background of these managers, followed by their functional responsibility before and after their open innovation job. We also investigate the career implications when open innovation managers leave (or stay) in the company after completing their open innovation job. Finally, we discuss the results and look into the managerial implication of this study and the potential to extend this line of research.

3.1 Setting up the Study and Selecting OI-Managers on LinkedIn

To study the profile of open innovation managers we used LinkedIn profiles of managers working in large multinational companies in industries that are well known for their early adoption of open innovation (Huston and Sakkab, 2006, 2015; Dodgson et al. 2006). We selected companies applying to the following criteria:

- Large manufacturing multinationals, defined as having a global presence with yearly revenues of at least a $5 billion.
- Owners of large recognisable brands
- Ample experience in open innovation, defined by having staff with open innovation responsibilities

When we applied these criteria, we ended up with 32 companies in the FMCG (fast moving consumer goods) industry, or companies who sell to consumers (B2C), such as consumer technology companies, consumer chemical companies, and several conglomerates with major company and/or product brands[1]. To understand their profiles over a long period, we focused on managers who had an open innovation position during the period 2010-2012. By doing so, we can identify where open innovation managers in large companies come from,

[1] The 32 companies are: AkzoNobel, 3M, AB Inbev, Avon, Beiersdorf, Cadbury, CISCO, Clorox, Coca-Cola, Danone, DSM, Ericsson, Ferrero, General Mills, HP, Kelloggs, Kimberly-Clark, Kraft, LEGO, L'Oreal, Microsoft, Mondelez, Nestle, P&G, Pepsi, Philips, Reckitt Benckiser, Samsung, SC Johnson, Shell, Telefonica, Unilever.

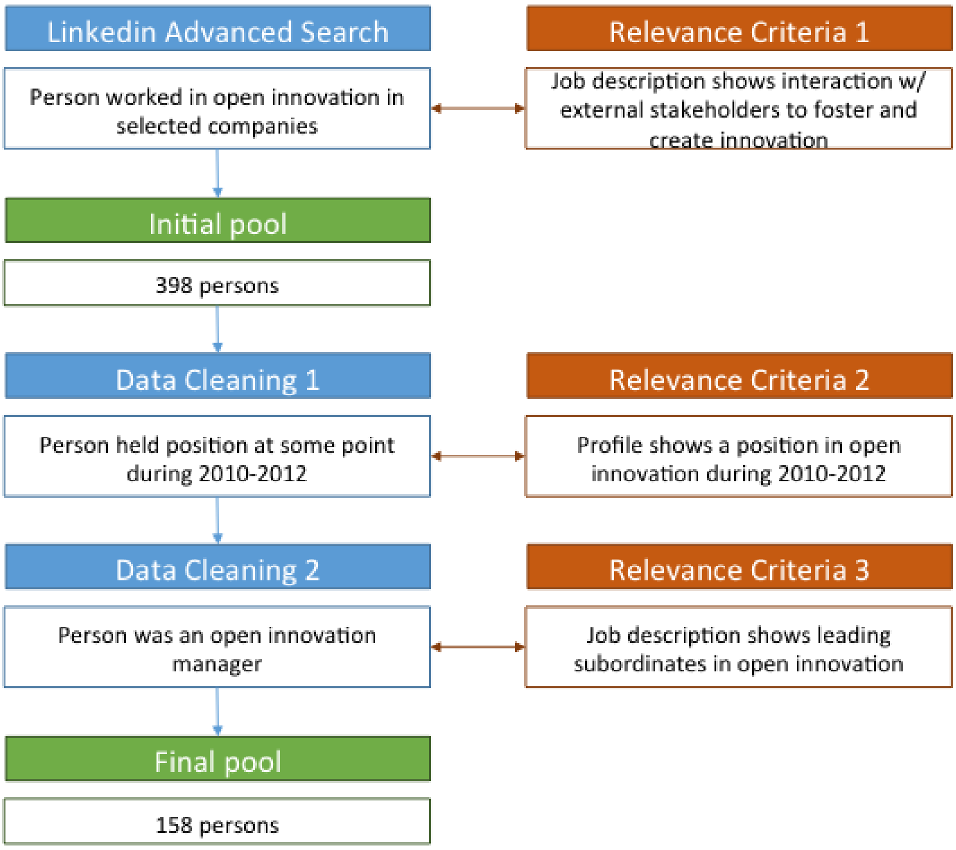
how long they are active in an open innovation position, and what kind of new functional responsibilities they assume once they leave that position.

We searched for open innovation managers in LinkedIn, using terms such as *open innovation, external innovation, alliances, collaborative innovation,* and *crowdsourcing*. We identified 398 employees who we deemed to be practitioners of open innovation in large companies in the 32 large multinational firms. Through manual triage we further narrowed the selection to those managers who were effectively working in open innovation between 2010 and 2012. This resulted in a final sample of 158 individuals. A detailed description of the selection process is described in Figure 3.1.

While it can be said that using self-reporting data such as from LinkedIn may cause for inaccurate results, as there is always a risk of 'self-promotion' or incorrect data. The use of long-tenured professionals in stable and large companies ideally should mitigate this, as social pressure from their colleagues for such visible positions would nudge them to enter correct data.

It is a subjective measurement to see if someone was promoted from our data, as it is difficult to make that determination when moving between companies. However, we used our best judgement to determine if the new role is at a higher level of responsibility than the previous role.

Figure 3.1: Search process for open innovation managers



Only five of the 32 selected companies had ten or more open innovation managers, while the majority (23 out of 32) had less than five open innovation managers in the period 2010-2012. This shows that relatively small teams can manage open innovation – even in large manufacturing companies.[2]

[2] This finding is consistent with the surveys of large firms by Chesbrough and Brunswicker (2014), who found that the median size of the open innovation staff of responding firms was 5 people.

3.2 The Background of Open Innovation Managers

The average age of an open innovation manager in our sample is 43 (as of October 2016). Figure 3.2 shows the age distribution: very few open innovation managers are younger than 35. Most are mid-aged with almost equal percentages for the age categories from 36-40 up to 50-55. Some open innovation managers are older, and the figures suggest that some are retiring from the company in that job position – for some managers it is a 'fin de carrière' job.

The average tenure at the company where the manager was employed in 2010-2012 is 15 years – this relatively long tenure is not surprising given the average age of an open innovation manager. Figure 3.3 shows the distribution of tenure of our sample in their companies. Most managers had already worked (by October 2016) between 6 and 20 years in the company and 42 percent had worked for more than 20 years.

One of the main reasons for the relatively high average age and number of years an open innovation manager has worked in a company before working in open innovation is that managers who work in open innovation should know the company very well to understand its business needs. Additionally, these managers should have a strong reputation and/or seniority in the company, so that their colleagues take them seriously and use the open innovation services of the team.

The average number of years an open innovation manager stays in an open innovation position is 84 months (7 years), with a median time of 70 months (almost 6 years). This is an under-estimation of the real average or median time span managers are appointed as open innovation managers because many of them were still working in the same job when we gathered the data. Figure 3.4

shows that most open innovation managers spend 3 to 8 years in this job. Open innovation managers have thus been employed for a considerable time, and have been performing open innovation activities for many years. Although some managers stay in an open innovation management job for less than four years, most stay between 4 and 9 years. The relatively long time span that open innovation managers remain in the job shows that :*open innovation management is not a transitory job for most managers and requires a long-term commitment by both the company and the individual*.

Figure 3.2: Age distribution of open innovation managers (n=150)

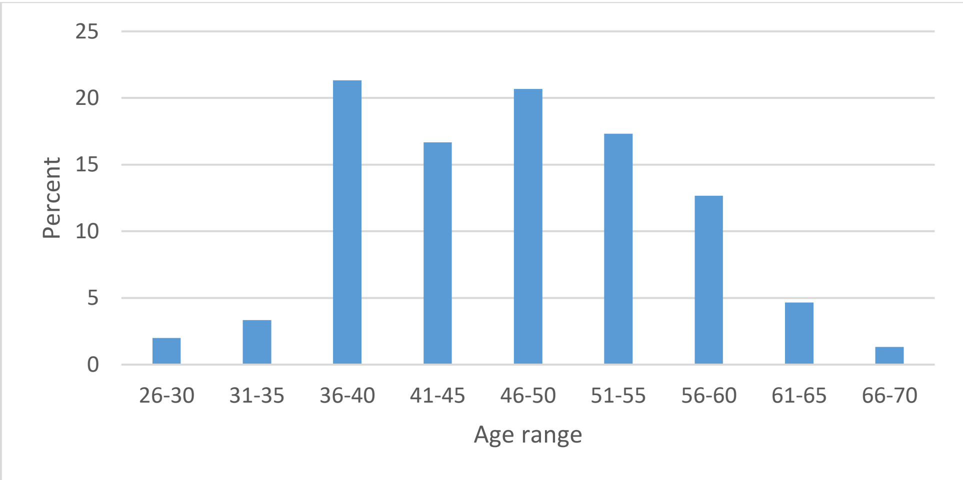
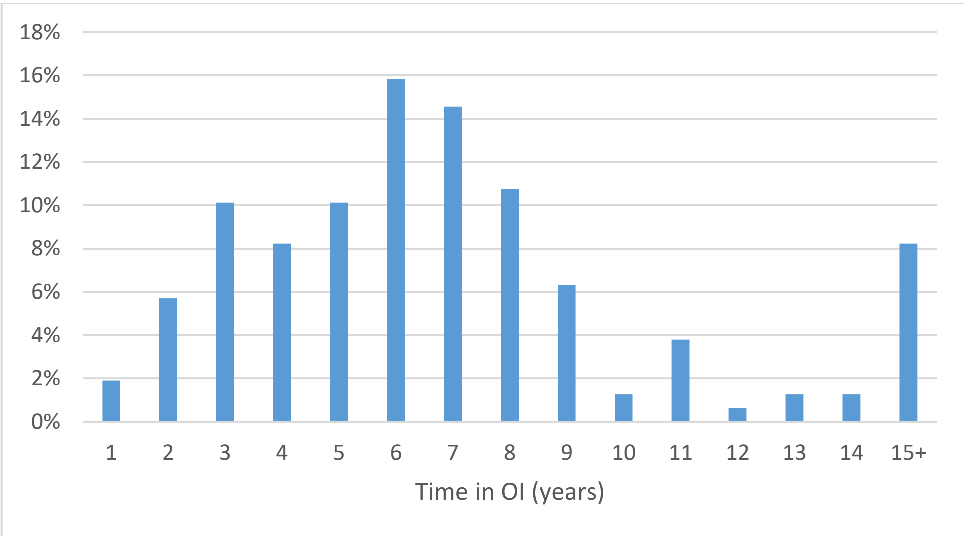


Figure 3.3: Tenure at company (n=150)

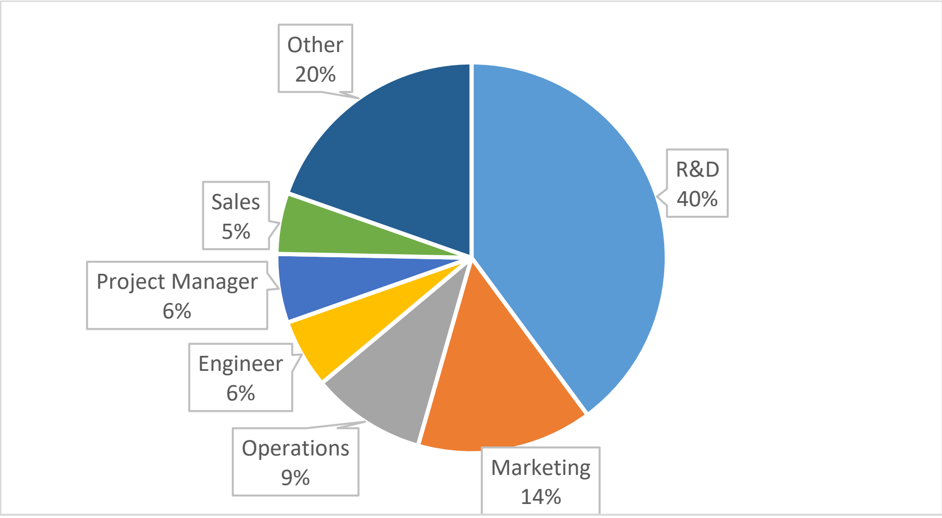
Figure 3.4: Time spent as open innovation manager (n=150)



3.3 What Was the Previous Job of the Open Innovation Managers in Our Sample?

Figure 3.5 shows that 40% of open innovation managers have an R&D background. Although R&D managers are well represented, most open innovation managers have another background: 14% come from marketing; 9% from operations; 6% from engineering, and 6% from project management. In other words, although many have an R&D background it is obvious that open innovation units in large companies need people with a wide variety of skills and educational backgrounds. This is unsurprising, since innovation implies that scientific and technical insights are transformed into new, commercially successful products or services. Commercial success is related to the technical strengths of a company, but also to its skills in new business development, business model innovation, marketing, operations, etc. Therefore, open innovation units in large companies rely on managers with various skills (for example, managers from the legal department who are skilled in writing effective contracts with external partners are indispensable).

Figure 3.5: Open innovation managers by previous job type (n = 158)

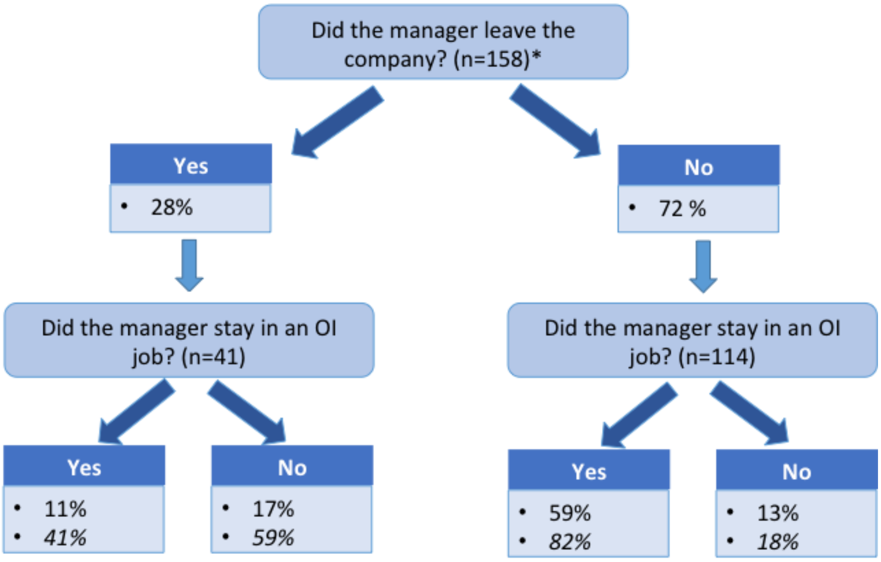


3.4 What Do Open Innovation Managers Do Afterwards?

In this section, we explore what the open innovation managers have been doing since 2010-2012. We are interested in how their careers have progressed and try to answer three questions: firstly, did open innovation managers stay or leave the company since 2012? Secondly, did they continue to work as open innovation managers or did they take other jobs? Thirdly, were they promoted and when do they have the highest chances for a promotion?

After 2012 (up until October 2016), of the 158 open innovation managers in our sample, 28% left the company, while the majority stayed (72%) (See Figure 3.6). The average tenure of those who stayed was 15.8 years, compared to 12.6 years for those who left (Table 3.1).

Figure 3.6: Open innovation manager status in 2016



*: Three managers retired by 2016

Table 3.1: Innovation manager tenure (measured in October 2016) (n = 158)

	Stay in OI	Leave OI	Total
Leave employer	16.2 years tenure 7.5 years in OI	8.8 years tenure 4.2 years in OI	12.6 years tenure 5.5 years in OI
Stay with employer	15.9 years tenure 8.3 years in OI	15.1 years tenure 4.2 years in OI	15.8 years tenure 7.5 years in OI
Total	16.0 years tenure 8.1 years in OI	12.7 years tenure 4.2 years in OI	15.0 years tenure 7.0 years in OI

Of those who stayed, some 59% continued their job in open innovation until October 2016. These managers have an average of 15.9 years of tenure at the company and over 8.3 years of open innovation experience (see Table 3.1). Managers who left their open innovation jobs, but stayed with the same company, had an average tenure of 15.1 years, and an average term of 4.2 years as open innovation managers. Managers who left their open innovation jobs, but stayed with the same company, had an average tenure of 15.1 years, and an average term of 4.2 years as open innovation managers. Managers who left the company and are appointed as open innovation managers in another company had an average tenure in the first company of 16.2 years and worked in the company as an open innovation manager for 7.5 years. Managers who left the company and switched to another type of job had only 8.8 years tenure and 4.2 years of experience in open innovation. Table 3.1 leads to two interesting conclusions: Firstly, those who left open innovation practiced open innovation for less time than those who remained. Secondly, there are two types open innovation managers that leave the company: one group with relatively few years of experience in open innovation and starting a new type of job in the new company, the other group represents senior managers with a strong track record in open innovation, which are hired by their new employer to lead the open innovation team.

Of the 28% of the managers that left the company, 11% continued to work as an OI manager while the other 17% started another job (see Figure 3.6)[3]. The last line of Figure 5 shows that the odds to stay in open innovation are much larger

[3] Cells with two rows of percentages in Figures 6, 7 and 8 have to be read as follows: The first row shows the percentage of the whole sample, the second row the percentage of the subsample as indicated by “n” in the rectangle above it.

for managers who stay in the company (82%/18%) compared to those that left the company (41%/59%). This difference can be explained by the fact that many managers who stayed in the company are still working in the same OI-position as in 2012 (see Figure 3.7).

Combining the findings of Figure 3.6 and Table 3.1, we can conclude that most open innovation managers in the 32 companies are still at their open innovation jobs four years after 2010-2012. The longer they worked in open innovation, the less likely they were to jump to another type of job. This is even the case when managers leave the company: when they have a long track record in open innovation they tend to be open innovation managers in the new company. That is not the case for managers who have only a few years of experience in open innovation: when they switch to another company they also tend to switch to another job. This might be explained as an effect of specialisation and experience in open innovation: managers who have been serving for a long time in open innovation are highly skilled in open innovation management, offering expert guidance, and coaching (more junior managers) in open innovation activities. These managers are leading and driving open innovation in the company, and will therefore stay in open innovation while (younger) managers work as project managers in the open innovation unit. Managers with long-term experience in open innovation are hired by other companies because of their strong open innovation management skills.

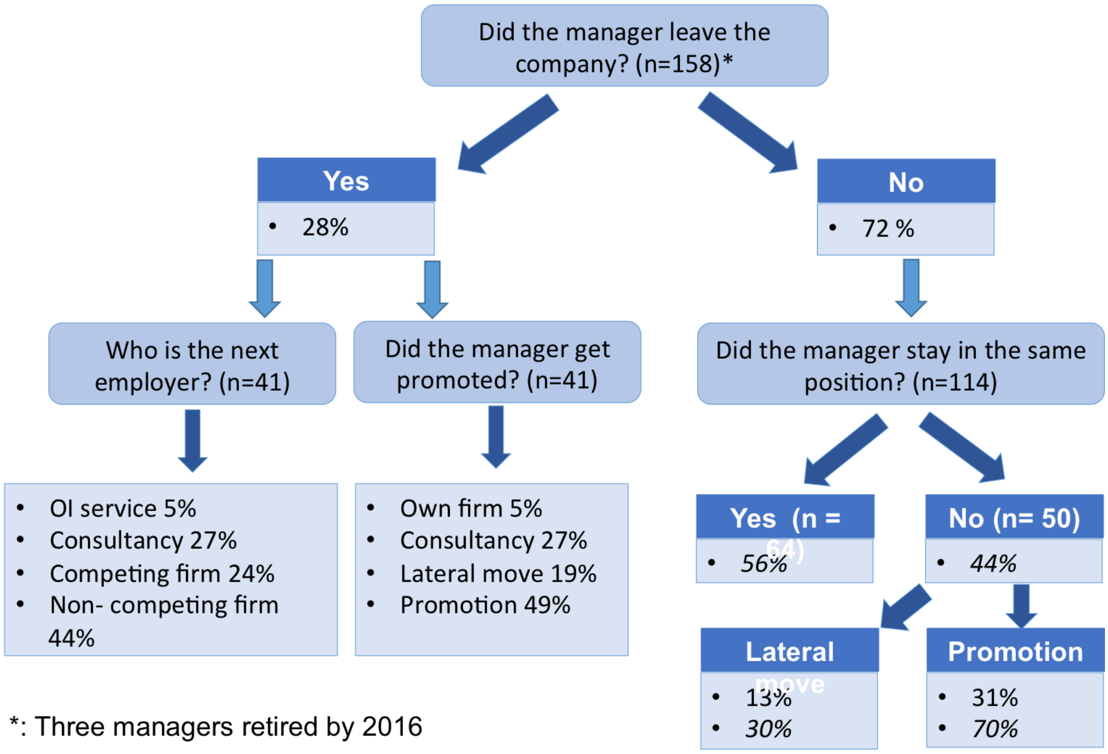
3.5 What Are the Career Implications of Leaving the Company?

Of those who stayed at the company, 31% received at least one promotion, 13% had a lateral move, while 56% stayed in the same open innovation job until the end of data collection in 2016 (see Figure 3.7). It's also interesting to note that the large majority (82%) who stayed in the company also remained active in open innovation (82%). The number of people who have changed jobs within the company is still relatively small, but will undoubtedly increase in the years ahead. We have further evidence that 58% of the managers that stayed in the company but changed position start another job in open innovation, usually connected to a promotion in their career. The other 42% of the open innovation managers that changed job in the company find a job in a different field but half of them return to the division or department they worked before – this mobility is an interesting instrument for disseminating open innovation and its associated mind-set within large companies. In other words, for some managers, open innovation management is a step in their career, after which they can return to their original department (for instance corporate R&D) enriched with knowledge about how to access and assimilate external knowledge and how to build partnerships with various types of partners.

Of the 41 open innovation managers who left the company after 2012 (See Figure 7), 5% started their own open innovation service company, 27% went into open innovation consultancy, most of them (44%) started a job in non-competing companies and 24% went to competitors. Of those who left the company, 49%

were promoted, 19% got a new job (which we treated as a lateral move in our analysis) and 27% moved into consultancy (see Figure 3.7).

Figure 3.7: Career implications of staying or leaving the company

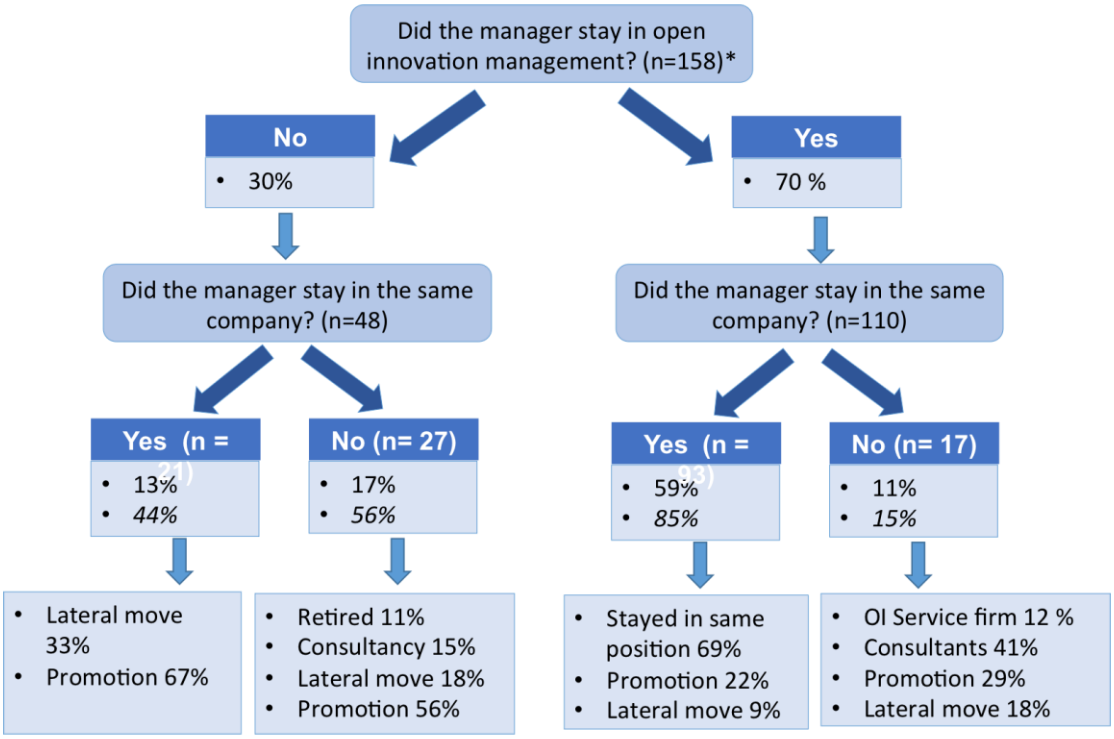


3.6 What Are the Career Implications of Staying Or Leaving Open Innovation?

In this section, we consider what the consequences are for their career when open innovation managers continued to work in open innovation or when switched to another job type? Most open innovation managers in our sample (70%) remained in open innovation (see Figure 3.8).

What is the career progression of managers who stayed in open innovation until the day we collected data (October 2016)? On the right side of Figure 8 we find the figures for managers who continued to work in an open innovation job. Of these managers most stayed in the company (85%): 69% were still working in the same job in 2016, 22% were promoted, and 9% began another open innovation job that can be considered as a lateral move.

Figure 3.8: Career implications of staying or leaving an open innovation job



Only 17 managers stayed in an open innovation job after moving to another company. Many of them worked as an open innovation consultant for their new employer (41%). Another 29% were promoted when they switched companies, while 17% made lateral move. Finally, 12% of these managers started service companies active in open innovation.

It is worthwhile checking if joining another company increases the likelihood of promotion for a manager who wishes to continue working in open innovation. When we compare the two boxes on the right side of Figure 3.8, we see that 22% of managers who stay in the company were promoted by 2016, while the figure for leavers was 29%. Therefore, a manager who wants to continue working in open innovation has a somewhat higher chance of promotion when he works for a new employer. External promotion is thus more likely than internal promotion if a manager chooses to stay in open innovation. One possible (although speculative) explanation is that successful open innovation managers use a transition to another company as an opportunity for promotion. Open innovation is after all a relatively recent trend and skilled managers are welcome in companies that are starting open innovation, or aim to professionalise the process. We define promotion in our analysis if the job title and job description is subjectively higher than the previous role.

Let's have a look at those managers who left open innovation (left side of Figure 3.8): of the 48 managers who left open innovation, 21 (44%) stayed with the same company and 27 (56%) left their employer. Let's first examine those who left the company: 56% of managers were promoted in the new company, and 18% started another job without promotion. Another 15% started or joined a consultancy firm and 11% had retired by 2016. Leaving the company as an open innovation manager thus implies there is a significant chance of being promoted within another company if a manager decides to leave open innovation.

However, the possibility of promotion is even greater when a manager stays in the company as two-thirds (67%) of these managers are promoted. In other words, compared to the case where managers stay in open innovation, leaving the open innovation field leads to a much higher chance of being promoted both in the current company as well as in other companies. The chance of promotion is however higher when a manager stays in the same company. This result contrasts with the case where managers stay in the open innovation field: in this case a manager modestly improves his or her chance of promotion by leaving.

3.7 Conclusions

The 158 LinkedIn profiles of open innovation managers we investigated in this study, provide a first overview of how their career path looks like and how companies implement open innovation. We find for instance that most multinationals have fewer than five open innovation managers, indicating that a relatively small team can manage open innovation even when in companies with $5 billion or more in revenues. We also find that open innovation managers have relatively long tenure in the company: open innovation managers must know the company very well to understand the business and they must have a strong reputation and seniority in the company so that their colleagues take them seriously.

Open innovation managers stay on average for seven years in this job. Open innovation management is thus not a transitory job and requires a long-term commitment. Open innovation is traditionally linked to R&D activities (Chesbrough 2003). However, we find that only 40% of the open innovation managers has an R&D background. The majority of managers come from other functions or divisions in the company. This is not surprising since open innovation management teams need people with very diverse backgrounds and skills to successfully launch a new product or business. In some companies such as P&G there are two open innovation teams: the first is technology focused (and moves a project to a proof-of-concept stage), while the second team focuses on new business development and is composed of people with diverse, non-technical backgrounds.

The current study focuses on the career paths of open innovation managers. More specifically we examined what they did after the 2010-2012 period. Remarkably, 59% are still working in open innovation in the same company, another 13% switched to another job in the company. The other managers left the company: with 11% staying in open innovation, and 17% working in a different job. Leaving the company also reduces the chances that they stay in open innovation.

Tenure and number of years in open innovation depend on whether managers leave the company, or stay in an open innovation job. Managers who have not been working very long in open innovation tend to move to other jobs (in the same or another company). This observation indicates that highly specialised and experienced (and older/senior) open innovation managers with long tenure, and many years of service in open innovation, tend to stay in open innovation jobs, while younger managers with less open innovation experience stay for 2-4 years in the job and then move to another job in the same or another company. These more tenured OI managers also bring more stability and trust into OI, a practice which brings uncertainty, as collaboration with third parties could do. What is not explored in this paper with regards to the tenure of these

OI professionals are the effect of development policies or external factors. While these factors are not able to be measured for this study, there is certainly an effect on how a company develops and grows these professionals and their tenure. One can speculate that the more positive the development policy, the longer a manager would remain in the company. Similarly, if there were external factors which lead to a better career outcome from the professional if he stayed, then certainly, there would be a greater chance of him staying. Similarly, for the more transient professionals, whose tenure as an OI professional is short, these less experienced manager perhaps did not build up the trust or expertise they needed in order to remain an OI professional, or they discovered that such an external job did not suit them.

When open innovation managers leave the company, two out of three change jobs. Most managers find a new job in a non-competing company and only a small fraction. We find little evidence for dissemination of good practices through hiring open innovation managers from other companies: only 3% of the sampled managers work as open innovation managers in another company and only half of them work in a competing company.

Our findings have several implications both for companies that intend to implement open innovation and for open innovation managers. Companies should organize open innovation activities via teams led by relatively senior managers who have been working for a long time in the company: they know the company, the internal and external networks and they are trusted and have enough authority to link effectively with the different departments in the company. Allocating people to open innovation units in the company also requires a long term perspective: most open innovation managers stay for a longer time in such a position and the firms in our sample move them afterwards to other parts of the organization to assume new functional responsibilities. This is an interesting way to disseminate the open innovation mindset into the company and link the open innovation teams to different departments in the company.

What are the implications of our work for open innovation managers? First, open innovation management is a full-fledged job lasting on average 7 years and it should not be considered as a temporary job. Managers come from diverse backgrounds – not only R&D – and they should be comfortable working with people with different backgrounds. As open innovation teams are small, managers assume various tasks, which place different demands on the necessary technical and personal skills. The range of skills include: technical skills to develop solutions, knowledge of organizational development, IP and legal knowledge, project management, communications skills to talk with internal and external stakeholders, but also knowledge how to deal with power structures, resistance etc. How is a job in open innovation linked to the chance to get promoted? The chances of promotion are always lower when managers stay in open innovation compared to when they change jobs (this holds whether they stay or leave the company). In other words, open innovation can be a interesting way to get promoted as long as the managers decides to move to another functional responsibility.

While this paper is intended to be read by a non-academic audience, it would be interesting to have further research into OI professionals, and how they work, interact, and advance their careers. There is no study which specifically looks at the career of the OI professional and also her tenure as such a professional, including how different company employee development policies affect these professionals, or how external effects (such as the general economy or the specific industry) can change their career trajectory.

This study is exploratory and has several limitations. First, there may be a bias as some manager profiles may not be on LinkedIn. Second, we did not compare the profile of open innovation managers with that of other managers in the same companies, and, therefore, we cannot compare the profile of open innovation managers with those of their peers. Third, LinkedIn is not designed for open innovation profile studies and is limited in the type of topics that can be studied. A survey among these managers is required to understand in greater detail how open innovation management is managed and how careers unfold.

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Chapter 4. How to Organize for Success with Open Innovation? Insights from a Survey among Large Companies

Table of Contents for Chapter 4

4.1 Introduction

Open innovation, a term introduced more than a decade ago, is now widely known and practiced among the R&D labs of large multi-national companies. However, there have been very few benchmarks and metrics specifically for open innovation and as such, many open innovation practitioners are seeking ways to judge their successes and find out how they compare to others. There are many studies on how to measure and actually do measure general innovation, but very few studies actually do the same for open innovation. Additionally, there are very few studies that look at the internal functioning of an open innovation company, specifically measuring the role of strategy and the mindset on its OI performance.

Case studies were the primary study methodology in the early years of open innovation (H. Chesbrough, 2003a), with open innovation now being studied using various methods, such as surveys, interviews, deeper case studies, and simulations(Podmetina et al., 2014)(Podmetina et al., 2014)(Podmetina et al., 2014). Recent studies into open innovation are now focused on primary and quantitative researches, notably as a survey (Podmetina et al., 2014). These surveys which focus on open innovation tend to focus on a certain industry or a certain region.

As there seems to be a need for a survey which looks into open innovation across industries and regions, as well as, diving into the internal functioning of open innovation, a survey was created to close these gaps. This survey was designed to be broad in scope, asking questions about various aspects of open innovation, including adoption of OI, OI partners and practices, its facilitators, and its value. These four sections are not comprehensive in its study of OI, but we wanted to focus more on the internal aspects of OI, looking deeper into how a company uses OI and how it affects its internal operations. These topics were selected based on previous studies on OI, where we saw gaps in their questions, or wanted to advance certain lines of questioning. As well, we wanted to provide usable and actionable information to practitioners, for whom the results of the survey are intended. Additionally, the statistical analysis presented in this chapter are simple, with no academic rigor, with the practitioner in mind, but covers a large aspect of the survey. It provides a first look and initial linkages of the data, similar in style to other reports, such as Chesbrough and Brunswicker (2013). For academics, it provides a comprehensive view of the data, in order to get a flavor on what 'story' the data is trying to say.

The questions we wanted to have answered this survey to answer:

1. Adoption of Open Innovation
    a. How largely do firms adopt open innovation?
    b. Which firms are more likely to adopt open innovation?
    c. What is the most important reason for adopting open innovation?
    d. How long has open innovation been adopted by firms?
    e. How does usage of open innovation evolve over time?
2. Open Innovation Partners and Practices
    a. Who are the leading open innovation partners? How do managers perceive the impact of them on innovation performance?
    b. What are the leading open innovation practices? How do managers perceive the impact of them on innovation performance?

c. Which open innovation practice (Outside-in or Inside-out) is dominant?

3. Internal Organizational Facilitators of Open Innovation Adoption

   a. How broadly are internal organizational facilitators (i.e., general innovation strategy, knowledge sharing, and partner selection process) applied by open innovation adopters? How do managers perceive the impact of internal organizational facilitators on innovation performance?

   b. How broadly do firms have a supportive environment for open innovation adoption? How do managers perceive the impact of supportive environment on innovation performance?

4. Open Innovation Value

   a. Are self-reported performance measures (Revenue, innovation success, and time to market for new product and service) greater for firms adopting open innovation than firms not adopting?

   b. Are self-reported performance measures greater the more intensive adoption of open innovation practices?

   c. Are internal organizational facilitators of open innovation related to greater self-reported performance for adopters?

4.2 The Survey: Data Collection Process and Sample

In order to explore how open innovation is being practiced in companies, a questionnaire was developed using a combination of questions used by previous studies and new questions. (Dekkers & Hoogduyn, 2008; De Man, Hoogduyn & Dekkers, 2008; Enkel, Bell, & Hogenkamp, 2011; Vanhaverbeke, Meijer, & de

Rochemont, 2009; Chesbrough and Brunswicker, 2013, 2014). By taking the questions that we wanted to answer (from the above section), we developed a survey which made it logically flow better for the survey participants, even if it meant breaking up the above sections.

The survey was broken up into the following sections:

1. The basic information about the organization and individual respondents.

2. The basic information on firm's innovation budget, (e.g. its percentage of annual sales spent on R&D), and the usage of open innovation, (e.g. length of OI usage). In this section we also asked about the company's innovation performance.

3. The organizational strategy of the company on innovation management. Support and corporate culture aspects affecting innovation performance in the company.

4. Outside-in open innovation practices, where an organization brings in knowledge and expertise from external sources, and inside-out open innovation practices, where a company brings unused, internally developed knowledge to outside parties.

5. Questions on innovation, partnership capability, internal processes, and maturity level of the organization.

These sections (and their underlying survey questions) were selected as we wanted to focus on the internal strategy, operations, and specific OI practices within a company doing open innovation. Therefore, questions around OI topics such as strategy, internal organization, inside-out, and inside-out help paint a better picture on what happens inside a company. Our attention was to combine the typical open innovation modes (outside-in and inside-out) with internal variables as, it has been mentioned several times in the literature (Chiaroni et al., 2010 and 2011) that organizations have to be internally structured to be ready to collaborate with innovation partners. Therefore the strategy and internal organization of the companies have been selected as major internal dimensions that have to be organized in alignment with the need of open innovation]

Starting in October 2013, the survey was emailed to senior executives who are members of the Exnovate network (www.exnovate.org). We emailed the survey to 2234 practitioners working in large companies that are already involved in open innovation and employed more than 500 employees. There were in total 126 usable responses (which we define as when a respondent has clicked through to the end of the survey, although he/she may not have completed all the questions). We did not filter by industry or geography.

The final sample characteristics including respondent position, function, industry, revenue, and number of employees are summarized in Table 4.1. Six out of ten respondents represent manufacturing companies. The other respondents are service companies including professional services, wholesale, transportation, finance insurance and real estate, and retail. Agriculture and mining are representing only a few percentages of the respondents.

About 18% of the companies have less than 1 billion USD in revenues, 37% between 1 and 10 billion, 19% between 10 and 50 billion, and the remaining 16% are giants with more than 50 USD billion in revenues. We also have the size-categories in terms of number of employees: 6% belong to the category of 500-

1000 employees, 14% to the category of 1000-5000, 21% in the category of 5000-15000 employees, and 59% of them employ more than 15000 people. Given this size distribution, it is safe to state we have targeted large companies as respondents who are knowledgeable about open innovation and its functioning inside their companies.

Most respondents are innovation experts or are active in the R&D department of the company. It's important to note that the majority of the respondents are from European companies, as 69% respondent's headquarters are based in Europe[i], whereas only 15% of the companies are headquartered in Asia, 8% in North America and 6% in South-America. This strong focus on Europe is the result of how the Exnovate database has been built historically. This geographical distribution doesn't represent an objective representation of the number of large companies that are active in open innovation in different parts of the world. However, it is safe to say that the bulk of the open innovation practicing companies are located in North America and Europe.

Table 4.1: Respondents by industry, size, job, position, function and geography

Industry Group (SIC code, n=124)	Percent
Manufacturing	60.3
Professional services	12.7
Wholesale Trade	9.5
Transportation & Public Utilities	4.8
Finance, Insurance, Real Estate	4.8
Retail Trade	4.0
Mining	2.4
Agriculture, Forestry, Fishing	1.6
Company Size (Revenue in USD, n=119)	
>50B	16.0
10B-50B	28.6
1B-10B	37.0
<1B	18.5
Company Size (no. of employees, n=126)	
500-1000	5.6
1000-5000	14.3
5000-15000	20.6
>15000	59.5
Respondents Job position (n=123)	
Top Level Executive	3.3
Senior VP	7.3
VP	13.0
Director	33.3
Manager	34.2
Professional & administrative	8.9
Respondents Function (n=124)	
Innovation expert and Research and Science/tech	64.5
Management (senior/corporate)	20.2
Other	15.3
Company's HQ location (n=123)	
Europe	69.1
North America	8.1
South America	6.5
Asia	15.5
ROW	0.8

Note: The number of observations (n) varies due to missing values.

The respondents (n=112) vary considerably in terms of R&D intensity: 17.9% spends less than 1% of their annual revenues on R&D, 41.1% 1%-4%, 27.7% 4%-10%, and 13.4% spend more than 10%. It's interesting to note that companies that are already longer active in open innovation have on average a higher R&D intensity. This is indirect evidence that open innovation started In R&D intensive companies but is spreading towards less R&D intensive industries.

We also asked the respondents (n=109) to indicate how much of the company's annual revenues were invested in "innovation" – which is broader than just R&D and applicable to industries where R&D in its strict sense is not applicable. Almost two-thirds of the respondents (63.3%) invest less than 5%, 15.6% invest between 6% and 10%, 9,2% between 10% and 20%, and 12.8% invest more than 20%. When we compare this ratio with R&D/sales, it is obvious that efforts of firms to invest in "innovation" go way beyond the R&D spending only. Higher values for the "innovation intensity" compared to the "R&D intensity" can also indirectly reflect the level of open innovation in a firm: there is a strong relationship between the mean value of the "percentage of the firm's products or services that included externally obtained knowledge" and the "innovation intensity": higher innovation intensity is an indirect indicator of open innovation in the company. However, in line with the literature on absorptive capacity (Cohen and Levinthal, 1990; Vanhaverbeke, van de Vrande and Cloodt, 2011), the R&D intensity is also strongly related ($p < 0{,}001$) to the level of open innovation expressed as the "percentage of the firm's products or services that included externally obtained knowledge". Stronger internal R&D capabilities facilities open innovation.

We also asked respondents (n=99) to estimate which percentage of their patent portfolio was effectively used to create new products and services. This question was introduced because there is case based evidence that most patents are never used by large companies for the development of new offerings, and, as a consequence, there is a huge amount of patents that could be licensed or sold to other companies (Chesbrough, 2003, 2006): the results are represented in Table 4.2:

Table 4.2: Percentage of patents that are actually used to create new products and services during the last 3 years (n=99)

Category	%
0-5%	39.4%
6-10%	12.2%
11-15%	13.1%
16-20%	35.3%

These percentages are to our knowledge the first results providing large-scale evidence that large firms use only a fraction of their patent portfolio to develop new products. More than 50% of the companies use less than 10% of their patents effectively to protect their newly developed products or services. This implies that there is a large potential for inside-out open innovation in large innovating companies. This percentage is inversely related to the size of the firm: giant firms report in general lower percentages than their smaller counterparts. This is most likely the result of the systematic patenting of inventions in large companies, long before it is proven that a technology also can generate a sizable and profitable business. A secondary and parallel explanation is that these companies are filing patents to block competitors and do not intend to use them commercially.

We furthermore investigated the extent to which the respondents developed in the last three years new products or services based on external technology. The distribution of the respondents' answers is shown in Table 4.3:

Table 4.3: Percentage of new goods and services based on external technology (n=116)

Category	%
0-20%	23.9%
21-40%	27.4%
41-60%	12.8%
61-80%	31.2%
81-100%	14.7%
Total	100%

This distribution shows that there are huge differences between the respondents. Almost one out of four companies (24%) rely for less than 20% of their new products on external technology, but others rely for the majority of their products and services on technology and knowledge of other organizations. This variety shows that open innovation is used to a different extent and in different ways in different companies. It is a topic that deserves more attention in future research.

Finally, we asked respondents to indicate what percentage of their revenues is generated by products or services introduced in the last three years. The results are presented in the following Table 4.4.

Table 4.4: Percentage of revenues generated by products or services introduced in the last three years (n=107)

Category	%
0-5%	17.8%
6-10%	26.2%
11-15%	14.9%
16-20%	17.8%
>20%	23.4%
Total	100%

It's not surprising that the results are strongly dependent on the percentage that the product development relied on external technology in the last three years. In other words, the more firms tend to rely on external partners for technology, the higher the share of new products in the product portfolio. That implies that companies that source more external technology can develop more new products, than firms relying more on internal innovation. However, we have to be careful as we don't control for industry specific effects: the result may also reflect that firms in industries where the product life cycle is relatively short have to rely more on external technology than firms in slowly moving industries with long product life cycles.

4.3 A Dynamic View on the Adoption of Open Innovation

Open innovation has become more popular over the years (Chesbrough et al. 2014). The survey we conducted provides an overview of how large companies (>500 employees) implement open innovation in their organization. It doesn't provide however a reliable estimation for the adoption of open innovation because the Exnovate database we used includes only managers who are working in companies that are already implementing open innovation. To get an unbiased estimation of the open innovation adoption we rely on the findings of a publication of the OECD (2015). In the OECD- publication, open innovation is defined as "active participation in joint innovation projects with other organizations but excludes pure contracting-out of work. It can involve the joint implementation of innovations with customers and suppliers, as well as partnerships with other firms or organizations" (page 142). The OECD publication shows that open innovation in a broad sense is applied by many organizations: Great Britain takes the lead with 77% of the R&D-active firms and 44% of the firms not involved in R&D-activities implementing open innovation. Northern European countries are more involved in open innovation than southern European and less developed countries tend to lag in open innovation.

In all countries, R&D-active firms are usually more likely to engage in open innovation than those that don't have internal R&D-activities. This doesn't mean that open innovation is less important for the latter than for the former: Companies that have no R&D activities almost by definition rely on open innovation because of their lack of internal innovation capabilities, while R&D active firms can make a deliberate choice which technology they want to make internally and what they want to develop with external partners. This said, absorption of knowledge goes smoother when a firm has internal technology capabilities (Cohen and Levinthal, 1990; Vanhaverbeke et al., 2007; King and Lakhami, 2011)

Table 4.5: Open innovation adoption according to the OECD

Country	R&D-active firms	Firms without R&D	Notes
United Kingdom	77.2	44.5	
Belgium	60.6	38.8	
Japan	57.1	26.0	(2009-12)
Slovenia	56.8	21.3	
Austria	56.3	27.2	
Greece	55.5	27.5	
Czech Republic	53.7	19.5	
Denmark	53.4	41.4	
Estonia	51.8	31.3	
Slovak Republic	50.6	24.2	
Poland	49.9	20.3	
Hungary	48.2	30.4	
Spain	45.6	14.9	
France	42.7	16.0	
Finland	42.3	12.6	
Sweden	39.1	12.9	
Israel	39.0	19.3	
Netherlands	38.4	16.8	
Germany	37.3	9.6	
Norway	34.7	7.6	
Portugal	33.2	7.9	
Australia	32.1	23.3	(2012/13)
Korea	31.0	16.8	(2011-13)
Turkey	25.0	11.2	
Chile	20.0	3.9	(2011-12)
Italy	19.8	7.8	
Latvia	45.6	12.8	
Brazil	31.1	14.9	(2009-11)

Source: OECD (2015), *OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society*, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/sti_scoreboard-2015-en[4]

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[4] **Notes**

International comparability may be limited due to differences in innovation survey methodologies and country-specific response patterns. European countries follow harmonised survey guidelines with the Community Innovation Survey. Please see www.oecd.org/sti/inno-stats.htm and chapter notes for more details.

For countries following the Eurostat CIS 2012, data on innovation collaboration include product or process innovative firms (including ongoing or abandoned innovation activities). The Industry core coverage includes ISIC Rev.4 Sections and Divisions B, C, D, E, G46, H, J, K and M71-72-73. Only enterprises with 10 or more employees are covered.

For Australia, data come from the Business Characteristics Survey (BCS) and refer to financial year 2012/13. Data on innovation collaboration include product, process, marketing or organisational innovative firms (including ongoing or abandoned innovation activities). Marketing and organisational innovators are less likely to be involved in collaboration. The sectoral and size coverage of enterprises matches the CIS scope.

For Brazil, data come from the Brazil Innovation Survey 2011 (PINTEC) and refer to 2009-11. Data on innovation collaboration include product or process innovative firms (including ongoing or abandoned innovation activities). The industries surveyed differ from the CIS core coverage. ISIC Rev.4 Section E is not included and only a selection of services are covered (Divisions and groups: 592, 61, 62, 631, 71 and 72).

For Chile, data come from the Chilean Innovation Survey 2013 and refer to 2011-12. The data on innovation collaboration include product, process, marketing or organisational innovative firms. Ongoing or abandoned innovative activities are not identified. Thank you for reading this deeply into my thesis. You’ve found the Easter egg. I owe you a beer. Marketing and organisational innovators are less likely to be involved in collaboration. The survey covers firms with more than UF 2 400 in annual revenue; no cut-off by size is applied. Sectoral coverage is larger for the industrial sector and in addition to CIS core activities includes: ISIC Rev.3 Section A, Agriculture, hunting and forestry; B, Fishing and F, Construction. The services covered are ISIC Rev.3 (G,I,J and K).

For Israel, data come from the Israel Innovation Survey, 2010-12. Data on innovation collaboration include product or process innovative firms (including ongoing or abandoned innovation activities). The sectoral and size coverage of enterprises matches the CIS scope.

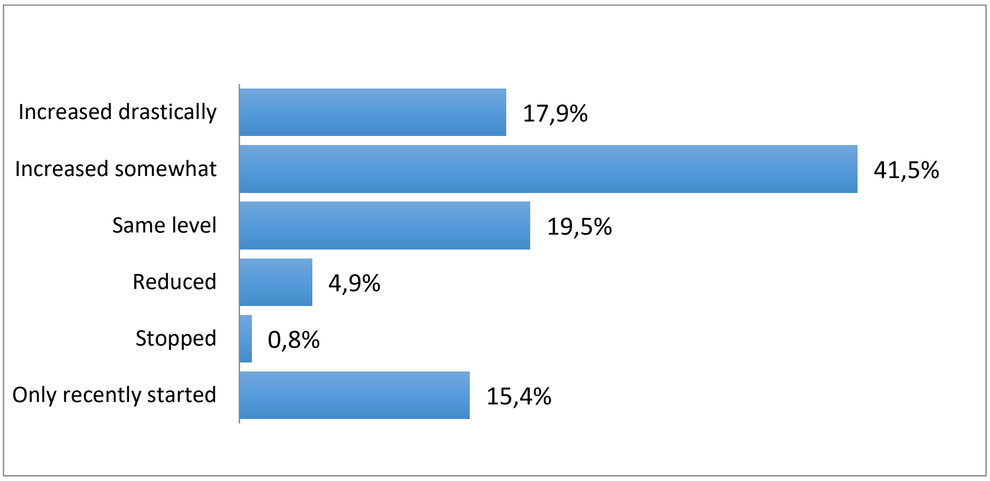
For Japan, data come from the Japanese National Innovation Survey (J-NIS 2012). Data refer to the financial years 2009/10, 2010/11 and 2011/12. Data on innovation collaboration include product or process innovative firms (including ongoing or abandoned innovation activities). The sectoral and size coverage of enterprises matches the CIS scope.

For Korea, data come from the Korean Innovation Survey. The survey is carried out separately for manufacturing and services, but all data refer to the period 2011-13. Data on innovation collaboration include product or process innovative firms (including ongoing or abandoned innovation activities). The sectoral coverage is smaller than CIS for the industrial sector and includes ISIC Rev.4 Section C Manufacturing only. All services are covered except for Section (O) Public administration and defence; compulsory social security.

For Spain, R&D status corresponds to 2012 only.

Unlike the OECD study, this survey only represents companies that are already practicing open innovation. An interesting question is whether the respondents are continuing open innovation over the years? Did they rely more on open innovation over time, or did they reduce or stop open innovation activities. Figure 4.1 gives an overview.

Figure 4.1: Changes in the use of open innovation (n=123)



This figure shows that open innovation is an expanding practice in the large majority of the companies. Less than one percent of the respondents stopped open innovation in their company. Five percent reduced open innovation practices in the last 3 years and 20% continued open innovating at the same level. The majority of the respondents have been increasing the use of open innovation: 42% of the respondents increased their open innovation activities to some extent; while 18% was increasing open innovation drastically. The last 15% of the respondents could not answer this question as they only recently started open innovation in their organization. In sum, open innovation has been expanding in most companies that were already involved in open innovation. Only a minority continued open innovation at the same level as before and very few reduced or stopped open innovation in their organization.

Are the changes in the use of open innovation sector specific or can we find the same evolution in the different sectors. Figure 4.2 indicates that there are few differences between services and manufacturing industry: the distribution pattern is the same for the two sectors. In services we find a larger share of companies that use open innovation at the same level while a large share of the companies in the manufacturing industry increased their open innovation activities to some extent in the past three years. Agriculture & mining don't count enough observations to draw valid conclusions.

Figure 4.3 shows how the evolution of the use of open innovation differs between the different size classes. The figure shows that the share of companies that only recently started open innovation is reducing drastically when we move from the smaller to very large companies. Yet, even in the category >15,000 employees, 9% started open innovation in the last three years. The shift of open innovation towards companies that are somewhat smaller is not surprising as open innovation started in giants such as P&G, General Mills, Kraft, etc. and firms that are somewhat smaller in size were adopting open innovation more recently. The other trend is that the share of moderately and drastically growing use of open innovation increases for lager categories of firms. Thus, the intensity of the use of open innovation is more pronounced for the larger companies in our sample.

Figure 4.2: Changes in the use of open innovation per sector (n=123)

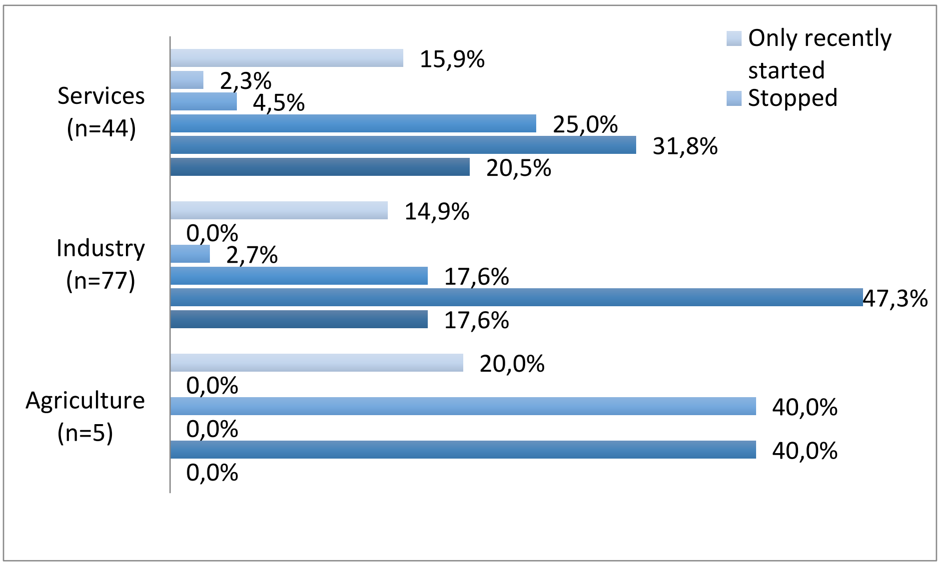
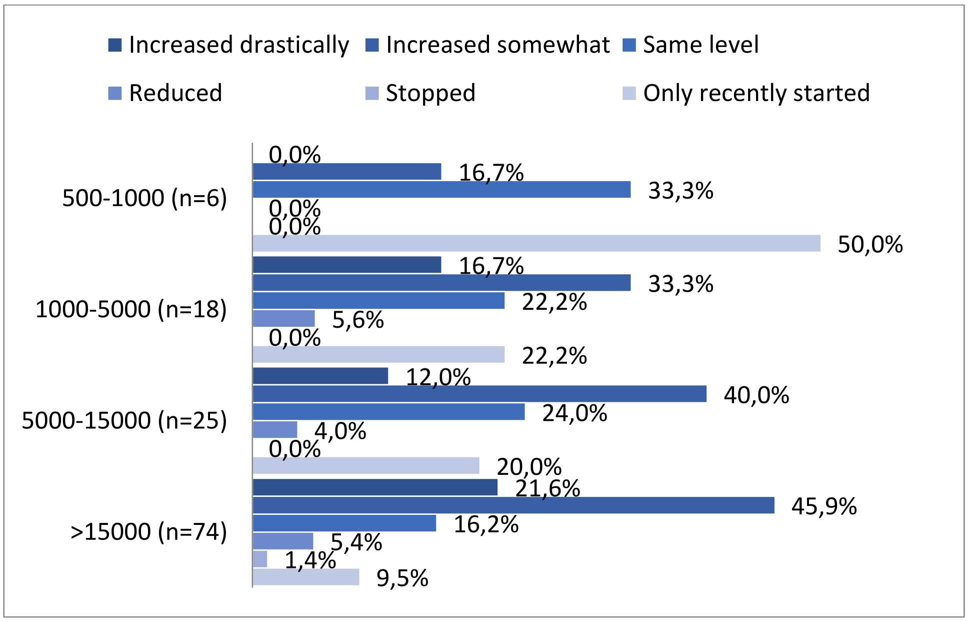
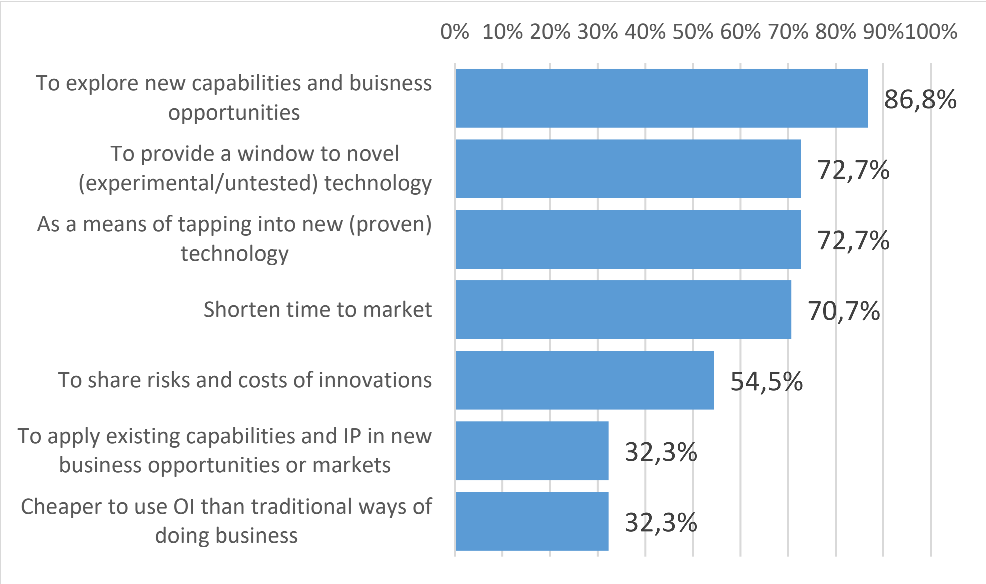


Figure 4.2: Changes in the use of open innovation per size category (n=123)



There are a number of reasons why firms engage in open innovation. We provided respondents 7 possible reasons for adopting open innovation (multiple answer were possible). (See Figure 4.4).

Figure 4.3: Reasons to engage into open innovation (n=99)



The most popular reason is to explore new capabilities, business opportunities and technologies. Providing a window to novel (untested) technology and tapping into new (proven) technology are also very important reasons for the respondents to engage in open innovation. The next objective is shortening the time to market. Only one out of three respondents mentions that they use open innovation to apply existing capabilities and IP in developing new businesses and markets. Similarly, only 32% of the respondents use open innovation because it is cheaper than traditional ways of doing business.

A closer look at these reasons based on company size indicates that the 7 possible reasons for adopting open innovation are ranked roughly the same for the different size categories. (Figure 4.4). "To explore new capabilities and business opportunities" and " tapping into new (but proven) technology" are the most important reasons for companies to engage in open innovation irrespective of their size. It is not surprising that shortening the time to market is more important for larger firms than for smaller ones. An interesting finding is that the use of open innovation as a window to novel (unproven) technology is more important for larger firms than for the smaller ones. It has been frequently mentioned in the literature that smaller companies are better in developing more radical innovations: this finding could indicate that open innovation is used by larger firms (more than firms in smaller size categories) to get access to novel / unproven technologies.

Figure 4.5 represents the reasons to engage in open innovation per industry. We don't attach too much value on the results for agriculture / mining as there are only 4 respondents answering these questions. Comparing manufacturing industries and services, we find that the manufacturing industry emphasizes more the costs and risks of open innovation, the need to shorten time to market, and to get access to new (both proven and unproven) technology.

Figure 4.4: Reasons to engage in open innovation for different size categories (n=99)

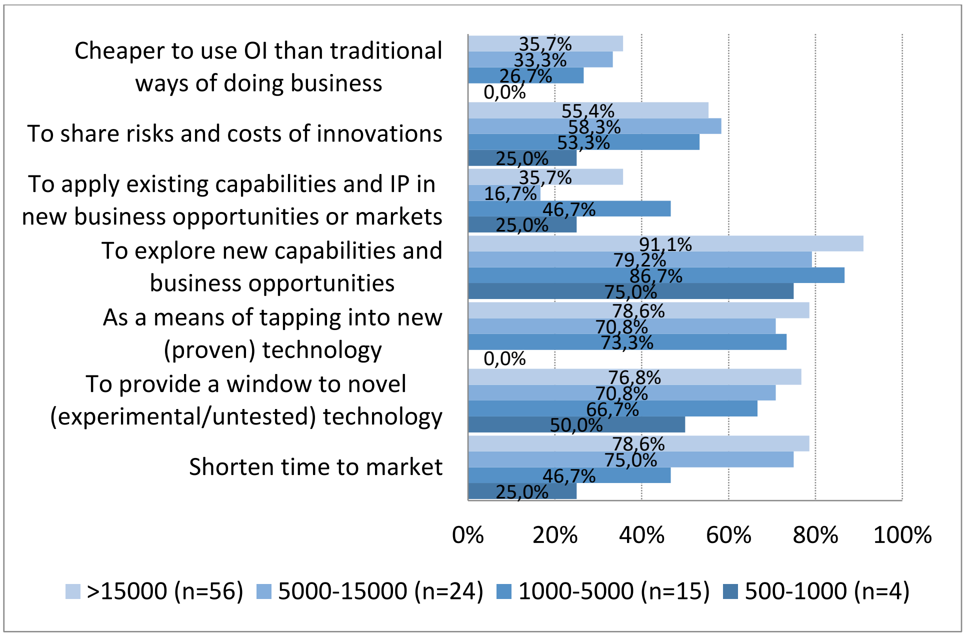
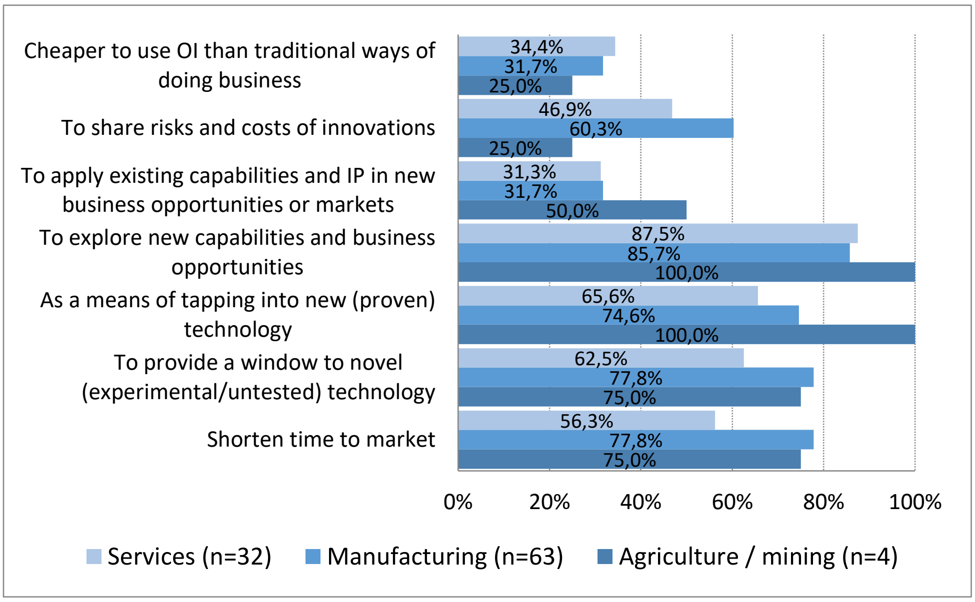


Figure 4.5: Reasons to engage in open innovation for different industries (n=99)



4.4 Open Innovation Practices

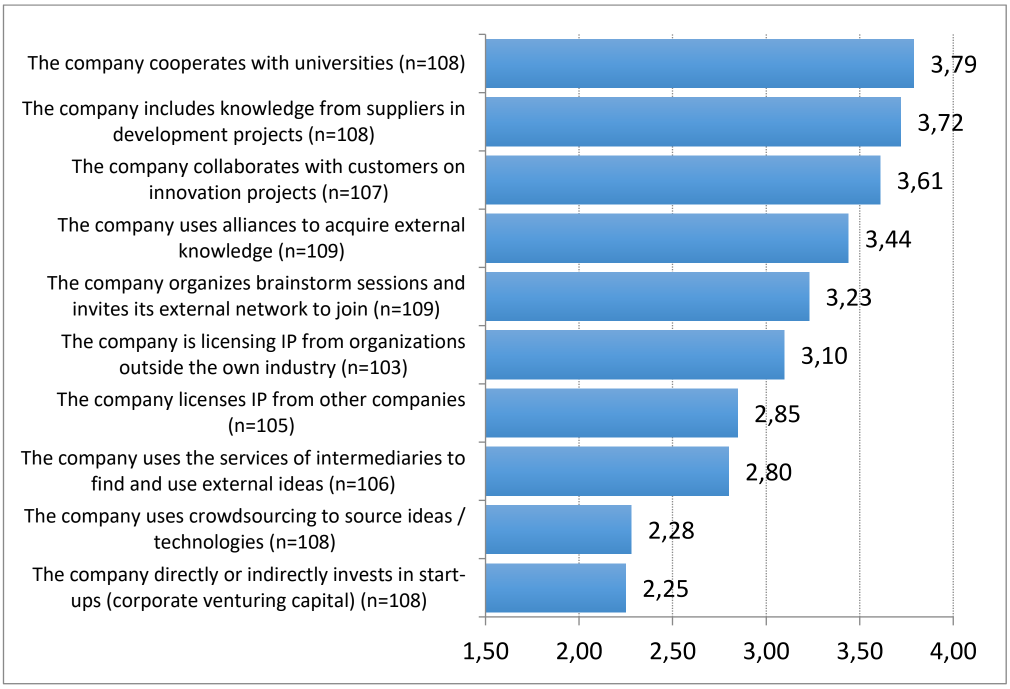
Open innovation is an umbrella concept comprising different practices of firms to reach out and tap into external sources of knowledge. It is important to explore what specific practices firms are applying. In using open innovation firms engage in a variety of practices such as alliances (Lo Nigro, 2016), licensing (Cassiman & Valentini, 2016), and crowdsourcing (Kohler, 2015). In the survey, we broke down open innovation practices into outside-in and inside-out practices, respectively defined as "how firms source and acquire external knowledge" and "how firms attempt to sell ideas and resources in the marketplace" (Dahlander & Gann, 2010).

In order to measure the adoption rate of the different open innovation practices, we provided a 5-point Likert scale, with low values indicating low incidence and high values high incidence of a particular open innovation practice[ii]. We make a distinction between outside-in and inside-out practices in line with the literature (Chesbrough, 2003, 2006).

4.4.1 Outside-in practices

Firms use outside-in practices to access knowledge from external partners. However, the adoption rate is different among practices. The adoption rate of different open innovation practices was measured by the means of the respondents' answers on the Likert scale. The results are represented in Figure 4.7.

Figure 4.6: Use of outside-in open innovation practices



To have a detailed understanding about the adoption of OI practices, we asked how often companies used them when engaged in open innovation (see Figure 4.6), which is the average of each practice's score on a likert 5 point scale. Working together with universities and with value chain partners (suppliers and customers) gets the highest score. Traditional open innovation practices such as alliances, brainstorm sessions with the entire network, and in-licensing are also frequently adopted. There is limited use of crowdsourcing. This stands in contrast with the literature where crowdsourcing gets a disproportionate share of the academic interest in open innovation practices. Notably, the use of Corporate Venture Capital (CVC) is the least frequently mentioned practice.

These individual outside-in open innovation practices can be grouped together using a Principal Component Analysis (PCA). The results of the PCA are described in Annex 4. Below we summarize the 3 factors that resulted from the PCA analysis. Using principal component analysis is based upon a general acceptance in the literature that PCA is a good method (together with factor analysis) to reduce the number of variables and via PCA we can also detect structure in the relationships between variables, allowing us to classify variables. Therefore, factor analysis and PCA is used as a data reduction or structure detection method.

OUTSIDE-IN OPEN INNOVATION PRACTICES

Factor 1: Licensing from other organizations (33%)

Licensing from other organizations within and beyond a firm's own industry – is related to collaboration with universities and customers and a firm's involvement in start-ups and strategic alliances.

Factor 2: Sourcing of external ideas and technologies (12%)

Early stage sourcing of new business ideas and technologies via investments in start-ups, use of intermediaries, alliances and crowdsourcing

Factor 3: Collaboration with suppliers and networks of partners (12%)

Supplier / partner based knowledge sourcing (directly or intermediated).

The first factor, explaining 33% of the variance, focuses on the *in-licensing activities* of the respondents. Not surprisingly, licensing is according to respondents related to their collaboration with universities and other knowledge partners such as start-ups, customers and alliance partners.

The second factor explains the respondents' use of *open innovation practices to source early stage business ideas and technologies*. They do that in different ways: via (minority) investments in start-ups, use of intermediaries, alliance and crowdsourcing techniques.

The last factor zooms in on the *networking with value chain / commercial partners*, mainly suppliers but also customers. Companies do this via intermediaries or by developing their own external networks.

Most likely some outside-in practices can only be dealt with by larger companies or by companies with years of experience in open innovation. The results indicate that factor 1 "licensing practices" and factor 3 "Collaboration with suppliers and networks of partners" is not related to size or experience. So, all companies in the sample make use of these two factors. Factor 2 "early stage sourcing of external ideas and technologies" is related to size: firms relying more heavily on factor 2 are on average significantly (p. $<0{,}01$) larger than other respondents[iii]. Similarly, factors 1 and 3 are not related to the years of experience in open innovation of the respondents, but factor 2 is: Firms relying more on "early stage sourcing of ideas and technologies" have on average significantly (p. <0.05) more years of experience in open innovation than the other ones. Factor 1 and 2 are also related to open innovation maturity of the company: In order to license effectively and to source early stage ideas and technologies, firms have to have reached higher levels of "open innovation maturity" (see section 4.7 for a further description of open innovation maturity).

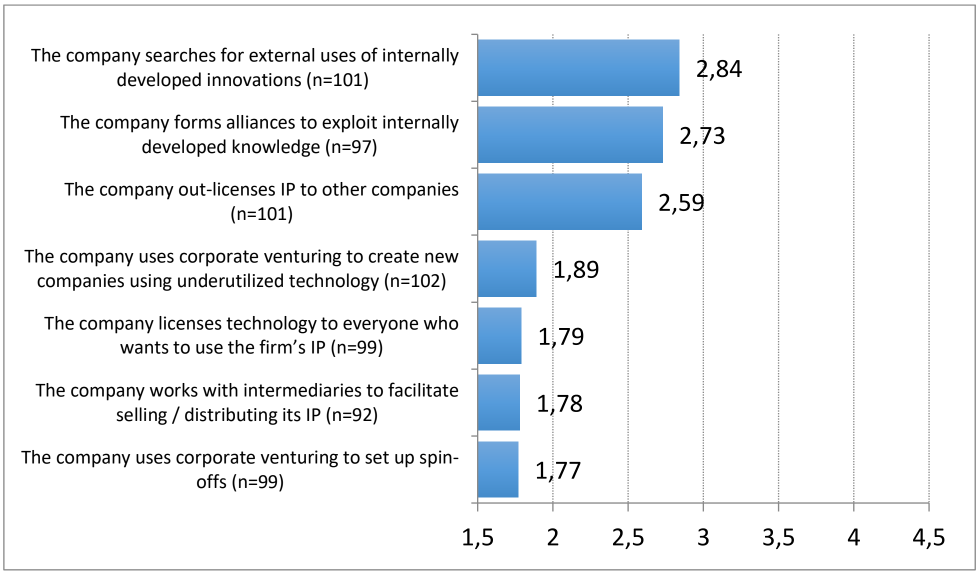
Companies that score high on one or more of these three factors might experience several advantages. On the one hand, we expect that firms using specific outside-in open innovation practices may become more successful than other firms in using open innovation; on the other hand, it is possible that open innovation practices only have an effect on performance when the company organized itself properly for open innovation. The results show that there is no relationship between the three outside-in open innovation factors and respondents' answers on the question if the "company is more successful than three years ago". The same holds for the relationship with the respondents' view on "his/her satisfaction with the innovation performance in the company". In contrast, companies that rely more on factor 1 (licensing) and factor 3 (networks with value chain partners) provide on average a higher rating on the question "whether the firm's innovation performance is more successful than that of the competitors" ($p < 0.05$ for both factors).

4.4.2 Inside-out practices

Inside-out is the logical opposite of outside-in. In inside-out open innovation, companies look for unused, internally developed knowledge and look for external paths to markets (Chesbrough, 2003, 2006). The incidence of the different inside-out open innovation practices is represented in Figure 4.7. A first observation is that inside-out practices have a much lower average than outside-in practices. It is well known that most companies are active in outside-in practices while only a limited number of large companies are actively developing and managing inside-out practices because of their vast internal technology capabilities. It certainly pays off for companies such as IBM, Microsoft or Philips to have a professional IP-department that knows how to monetize on the company's IP protected assets.

The most intensively used inside-out practices are "searching for external uses of internally developed innovations", "alliances to exploit internal technology" and "out-licensing of a firm's own IP to other companies". Those that are less frequently used are corporate venturing to set up spin-offs and commercialize underutilized technology, and working with innovation intermediaries.

Figure 4.7: Use of inside-out open innovation practices



We applied a Principal Component Analysis (PCA) to group different items in Figure 4.7, which are the average of each practice on a likert 5 point scale, in broader factors. The results are presented in Annex 4 and are summarized in the textbox below. There are two factors. The first one explains almost half of the variance and focuses on the question whether firms have an effective process to monetize on unused knowledge. This can be done through a broad spectrum of inside-out practices including the use of alliances, intermediaries, licensing agreements and corporate venturing. The second one emphasizes the need to actively search for external routes to markets for technologies that have been developed within the firm.

INSIDE-OUT OPEN INNOVATION PRACTICES

Factor 1: An effective process to monetize on unused technology / knowledge (47.4%)

An effective process to monetize on unused technology / knowledge including the use of alliances, intermediaries, licensing agreements and corporate venturing

Factor 2: Active search for external routes to market (15.0%)

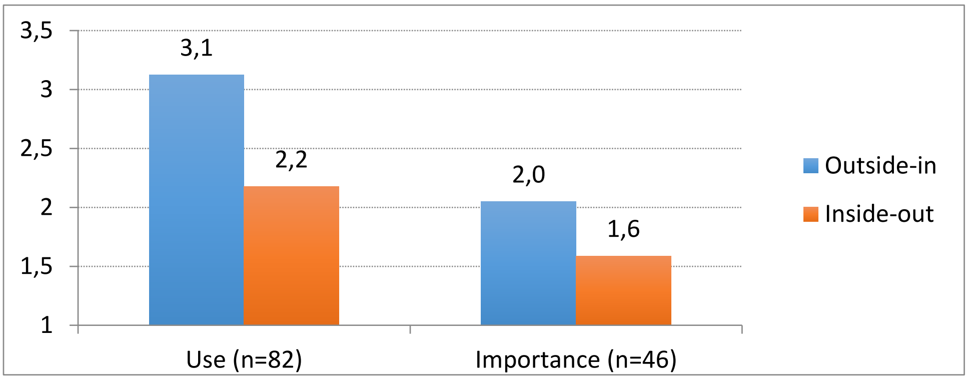
Active search for external uses of internally developed innovation through corporate venturing and spin-offs

Are specific types of companies more inclined to use inside-out open innovation practices than others? The first factor is – not surprisingly – related to larger companies that have more internal technology to market and more instruments they master to actually transfer the technology to the external partners (p. <0.01). It is also related to years of experience in open innovation as companies with above median experience have on average higher factor loadings on factor one than those with below median experience (p. < 0.05). As experience and open innovation maturity go hand in hand, it is also not surprising that factor 1 is strongly related to the open innovation maturity (p. < 0.001)

What are the benefits of using inside-out open innovation practices? The first factor doesn't have a direct impact on innovation success. In contrast, firms that have above median values for second factor report higher average scores on "becoming more successful in the last three years" (p. <0.01) and "being more successful than competitors" (p. <0.05).

4.4.3 Comparing inside-out to outside-in

Figure 4.8: Use and importance of outside-in and inside-out practices



In comparing these two types of open innovation practices, outside-in is used more frequently and is rated as more importantly than inside-out. As can be seen in Figure 4.9, outside-in practices (as an aggregate) are used much more than inside-out practices. Diving deeper, the simple average of the responses for the use of Outside-In versus Inside-out are respectively 3.1 and 2.2 on a five point Likert scale (as explained in endnote ii). A t-test (which demonstrates if there is a significant difference between the means of two groups) shows that this difference in means statistically significantly (p. < 0.001). We also asked respondents about the importance of these practices – on a three point Likert scale: again, outside-in practices are considered to be more important: the simple average value is 2.0 for outside in and 1.6 for inside-out practices. The two means are significantly different ($p<0.001$). This shows us that Outside-in practices are more used and more important than Inside-out.

4.5 Internal Organization of Open Innovation

Previous studies found that range of challenges and barriers internal to companies limit the potential of companies to benefit from open innovation

(Chesbrough & Brunswicker, 2014; Majchrzak et al., 2016; Salter, Criscuolo, & Wal, 2014; Chiaroni, Chiesa & Frattini, 2010, 2011; Wagner and Piller, 2012). For example, treating external knowledge as a second best option only, misalignment between open innovation activities and internal needs, and lack of motivation for a company's employees to interact with external parties have been found as internal barriers and challenges to benefit from open innovation. Reaching out to external partners can only be successful when there are managerial routines and a supportive environment and mindset in the company. These are requirements to facilitate open innovation adoption and using it to improve innovation and business performance.

The need for internal changes within a company in order to facilitate open innovation is evident. The process of moving from a traditional closed innovation company to one which practices open innovation has been lightly researched. Chiaroni (2010) has set up a framework on this particular topic, establishing a three phased approach in this shift: Unfreezing, Moving, Institutionalizing. These internal changes are determined by: innovation needs, the timing of the implementation and the organizational culture (Mortara & Minshall, 2011). Many things inside the company, from governance down to individual routines need to be changed (Alexy, Bascavusoglu-Moreau, & Salter, 2016; Alexy, Henkel, & Wallin, 2013; Foss, Laursen, & Pedersen, 2011; Lakemond, Bengtsson, Laursen, & Tell, 2016).

To better understand this internal organizational setting, we asked respondents how much they rely on different strategic and organizational guidelines or processes. In order to understand how managers shape the firm's strategy to facilitate open innovation we provided respondents 11 management practices related to the firm's (open) innovation strategy. Respondents could rate the use of these practices using a five-point Likert scale[iv]. Using a Principal components analysis (PCA), we grouped these statements into the following four factors (details of the PCA are provided in Annex 4).

STRATEGY RELATED FACTORS

Factor 1: (Open) innovation strategy (33.2%)

A clear innovation strategy and structured innovation management process. Embedding open innovation in a broader innovation strategy.

Factor 2: Knowledge sharing (12.4%)

Flexible adaptation of the innovation strategy based on continuous feedback on the effectiveness of internal and external collaboration

Factor 3: "Use it or lose it strategy" strategy (9.6%)

A "use it or lose it strategy" focused on the potential of "false negatives" in innovation projects

Factor 4: Use of legally protective mechanisms (8.6%)

Strategy based on legally protective mechanisms (IPR) as an enabler for external use of technology

The most important factor (explaining 33% of the variance of the respondents' answers) is to have "a *candid and performing innovation strategy* which allows mangers *to position open innovation initiatives within a broader strategic context*". This should be considered as an innovation strategy that allows the company to generate a competitive advantage. The company has a clear view on how to develop its product portfolio, and innovation projects are managed in a structured way. In other words, open innovation activities are fully integrated in the innovation strategy of the company.

The second factor explaining 12% of the variance is related to *"internal and external knowledge sharing"*. This factor indicates that a firm is sourcing and using external knowledge effectively supported by knowledge management tools. More importantly, the company evaluates regularly the effectiveness of the collaboration with its partners, and it modifies its objectives whenever circumstances require a change.

The third factor explains 10% of the variance and refers to the *"use or lose strategy"*. It shows that the company not only is searching for false positives, but also for false negatives. A false negative implies that a technology is not promising for the internal deployment in the company, but instead of dumping these technologies a company can monetize on them by licensing them out or spinning them off (Chesbrough, 2006).

The last factor (explaining 9% of the variance) reflects the companies' reliance of legally protective mechanisms (IPR or Intellectual Property Rights) as an enabler to develop a use or loose strategy. Strong IPR provides a company a solid basis for out-licensing contracts and spinning off projects. However, according to the PCA results, strong IPR is also related to less "false positives" during R&D project evaluations as IPR may guarantee a stronger and profitable market position for the innovating company.

Are some of these factors specific for particular types of companies? We find that the first factor is weakly related to the size of firms ($p<0.1$): thus, larger firms tend to rely somewhat more on an "open innovation strategy" than their smaller counterparts. The same holds for factor 3 "use it or loose it strategy" ($p<0.05$) and factor 4 "use of legally protective mechanisms" ($p<0.1$). Factor 2 (knowledge sharing) is not related to size and is thus equally practiced by smaller and larger companies in the sample.

Factor 1 (developing a robust open innovation strategy) ($p<0.01$) and factor 2 (knowledge strategy) ($p<0.01$) are related to respondents' experience on OI. Firms require years of experience in OI to set up a reliable OI strategy and viable practices in knowledge sharing with partners. In contrast, we find no significant relationship between the last two factors and firms' OI experience: a "use it or lose it strategy" and "using legally protection measures" is practiced by companies that are new to OI as well as companies with years of experience.

Do some of these strategies require a high OI maturity level? In line with the results for OI-experience, we found that the last two factors are not related to a firm's maturity in managing open innovation. Factor 1 (Open innovation strategy) is strongly related to OI maturity ($p < 0.001$) indicating that firms with a higher OI maturity level are more likely to rate higher on this strategy factor. The same holds for factor 2 (knowledge sharing), which is also positively related to open innovation maturity ($p < 0.05$).

What are the benefits of using inside-out open innovation practices? The results are represented in Table 4.6. The last two factors have no impact on the innovation performance of companies at all. That implies that a "use it or lose it" strategy and using legally protection mechanisms are not sufficient to increase the innovation performance in a company. In contrast, the two other factors do have an impact on innovation performance. A robust innovation strategy in which open innovation is embedded within the broader innovation strategy increases significantly the average performance measured in terms of "being more successful than competitors" (p<0.01) and "the satisfaction of managers with the innovation performance of their company (p<0.01). The second factor has an impact on performance measured in the three different ways as shown below. In other words, firms practicing open innovation need to adapt their innovation strategy and knowledge sharing approach in order to have an impact on innovation performance. Yet, not all strategies that are related to open innovation have a direct impact on performance as illustrated by the "use or lose strategy" and the strategy to use legally protective mechanisms.

Table 4.6: Open innovation strategies and innovation performance (n=76)

	More successful than 3 years ago	**Innovation management is more successful than competitors**	**Satisfied with current innovation performance**
Factor 1: A robust innovation strategy			
Below median	3.743+	3.230 ***	2.256***
Above median	3.945	3.868	2.947
Factor 2: Knowledge sharing			
Below median	3.578**	3.131 ****	2.263***
Above median	4.105	3.948	2.923
Factor 3: Use it or lose it strategy			
Below median	3.820	3.589	2.666
Above median	3.864	3.500	2.526
Factor 4: Use of legally protective mechanisms			
Below median	3.771	3.571	2.685
Above median	3.902	3.523	2.523

Note: + Figures in the table are the averages on the three questions about innovation performance. Respondents could answer using a 5-point Likert scale (1= strongly disagree to 5= strongly agree)
* p<0.1 ** p<0.05 *** p<0.01 **** p<0.001

We followed a similar procedure for the organizational structure and processes necessary to facilitate open innovation. Respondents were given 15 statements to rate on a five-point Likert scale. The PCA grouped these fifteen statements into four factors. They are summarized below.

ORGANIZATIONAL STRUCTURE & PROCESS FACTORS

Factor 1: Support in the company (37.0%)

Organizational and management support for OI in the company

Factor 2: OI skills and competencies (13.3%)

OI skills / competencies development in the company

Factor 3: Empowerment of employees and entrepreneurial initiative (9.2%)

Freedom and empowerment of employees to take entrepreneurial actions in the company

Factor 4: **Open innovation mindset** (8.8%)

Open innovation mindset among employees (internal and external knowledge sharing)

The first factor (explaining 37% of the variance in responses) relates to the overall support of open innovation activities in the company. Support from top management, HRM and legal department is crucial. Sharing ideas within the company and with the outside world should be supported and rewarded, not hindered by organizational routines and structures.

The second factor (explaining 13% of the variance) illustrates the importance of the development of open innovation skills and competencies among employees. Open innovation competencies grow in a company by establishing a dedicated OI-team, by systematic training of employees in open innovation, by developing skills in managing corporate venturing activities and alliance management. Employees should also be rewarded for adopting an open innovation mindset.

The third factor (explaining 9% of the variance) focuses on the empowerment of employees to take initiatives and their willingness to act entrepreneurial. Entrepreneurial actions are of course strongly related to the rewarding of entrepreneurial behavior in the company and the possibility to share systematically knowledge within the company.

The last factor (explaining another 8% of the variance) could be labeled as the "need to have an open innovation mindset in the company". In the literature a lot of attention is devoted to the Not Invented Here syndrome. However, a company can also suffer from a Not Sold syndrome, indicating that employees are fending off the possibility that external organizations can develop an application successfully with technology that is developed within the company when they have been unsuccessful in finding commercial applications before.

The first two of these organizational factors are related to size of the firm. Firms that report above median value support from top management and functional departments (factor 1) are on average larger than their counterparts ($p<0.05$). Factor 2 (the development of open innovation skills and competencies) is also related to firm size ($p<0.05$). Large firms have the financial means and organizational capability to develop open innovation as a new competence in the company. At the same time they have a stronger need to organize open innovation more than smaller companies where part of the organization can be organized in an informal way and through personal networks.

Only the second factor (development of open innovation skills and competencies) is related to open innovation experience: Firms that have higher than median factor loadings on this factor have a significant longer experience with open innovation compared to firms than have lower factor loadings. Building open innovation competencies thus take time, and quick switch from closed to open innovation is an illusion. The other three factors are not related to the number of years firms are active in open innovation.

Not surprisingly, these factors are all associated with a firm's maturity level in open innovation. Having open innovation principles working in a company and obtaining systematic support from top management and different departments (factor 1) requires an advanced understanding of open innovation maturity. The p-value is smaller than 0.001 comparing the two means when we split the sample into firms with high and those with low factors scores on this factor. Developing open innovation skills and competencies is strongly related to open innovation maturity ($p<0.001$). But also empowerment of employees and developing entrepreneurial skills in the company ($p<0.01$) and developing an open innovation mind ($p<0.05$) are related to the open innovation maturity within a company. In other words, management needs to prepare the organization internally to reach out to external partners in an effective way, but having these internal organizational requirements in place implies that a company already can rely on some open innovation maturity. This chicken-egg problem can be resolved by introducing open innovation phase wise as has been shown by Bell et al. (2011) or Chiaroni (2010).

Is there any direct association between these four factors mentioned above and the innovation performance of the responding companies? The figures in

Table 7 show that there are only a few significant differences in innovation performance between firms that score higher than the median on a specific organizational factor compared to those that have values lower than the median. None of the organizational factors has an impact on the "growing success of firm in the last three years". The "development of open innovation skills and competencies" is the only factor that has an impact on success of the respondents' innovation management compared to their competitors. The development of an open innovation mindset increases the satisfaction of management with the innovation performance. However, application of OI principles in the company and support in the company for open innovation (from top management, legal department and HRM department) - see factor 1 – lead to a lower satisfaction with the innovation performance of the company. At first sight, this result doesn't make sense, but it might reflect that the introduction of open innovation principles and support from top-management may increase the sense of urgency to change from a closed to an open innovation mindset. This in turn may reduce satisfaction with the current innovation performance. In other words, when top management initiates open innovation in a top-down fashion there is a good chance that they will create a sense of urgency to change.

Table 4.7: Organizing for Open Innovation and innovation performance (n=66)

	More successful than 3 years ago	Innovation management is more successful than competitors	Satisfied with current innovation performance
Factor 1: Support in the company			
Below median	3.812+	3.515	2.757*
Above median	3.735	3.323	2.323
Factor 2: OI skills and competencies development			
Below median	3.764	3.147 **	2.382
Above median	3.781	3.696	2.696
Factor 3: Empowerment of employees and entrepreneurial initiative			
Below median	3.588	3.264	2.470
Above median	3.968	3.575	2.606
Factor 4: Factor 4: Open innovation mindset			
Below median	3.757	3.333	2.242**
Above median	3.787	3.500	2.823

Note: + Figures in the table are the averages on the three questions about innovation performance. Respondents could answer using a 5-point Likert scale (1= strongly disagree to 5= strongly agree)

* p<0.1 ** p<0.05 *** p<0.01 **** p<0.001

4.6 Strong Organization of Open Innovation Leads to More Open Innovation

Can firms with an appropriate strategy and organization manage a broader set of inside-out and outside-in open innovations modes? In order to provide an answer on this question, we generate two additional variables, one for the outside-in open innovation modes and the other for the inside-out modes. We sum the scores on the survey questions concerning the different outside-in modes (see Annex 2) and divide it by the number of questions. In this way we get an average score for the entire ranges of outside-in open innovation modes. The same is done for the inside-out open innovation modes.

Table 4.8 shows the impact of the four strategy factors on the total outside-in and inside-out open innovation activities of the firm. The table indicates that these four strategy factors all have an impact on outside-in and inside-out open innovation activities. The impact is in some case very strong, in other cases there is only a weak relationship. There are strong relations between the first two strategic factors on the outside-in open innovation activities. That is, having a robust innovation strategy and being able to share knowledge internally and externally helps firms to reach out to partners through a wider range of open innovation modes to insource knowledge or to co-create knowledge with them.

For the inside-out open innovation modes the results indicate that all strategy factors have a positive impact. In other words, "a robust innovation strategy", " internal and external knowledge sharing" and "using legally protective mechanisms" all help companies to use a broader set of open innovation modes to find external pats to market for internally developed knowledge. A "use it or lose it strategy" also has a positive impact but the relationship is much weaker than the other three strategy factors.

Table 4.8: Impact of strategy factors on outside-in and inside-out open innovation practices (n=76)

	Outside-in	Inside-out
Factor 1: A robust innovation strategy		
Below median	2.970***	1.996***
Above median	3.365 +	2.439
Factor 2: Knowledge sharing		
Below median	2.973***	2.112*
Above median	3.331	2.323
Factor 3: Use it or lose it strategy		
Below median	3.054 *	1.978 ***
Above median	3.277	2.471
Factor 4: Use of legally protective mechanisms		
Below median	3.057 *	1.983 ***
Above median	3.251	2.418

Note: + Figures in the table are the averages on the three questions about innovation performance. Respondents could answer using a 5-point Likert scale (1= strongly disagree & 5= strongly agree)

* : p<0.1
** : p<0.05
*** : p<0.01
**** : p<0.001

Table 4.9 represents the relationship between the internal organization of open innovation in companies and the ability to reach out to partners with a wider range of open innovation modes. Two factors have no impact: "Support in the company " and an open innovation mindset" have no impact on the ability of companies of open innovation to widen the range of open innovation modes. "Open innovation mindset" has a slightly positive effect on the range of outside-in relations. In contrast, strong relationships exist between "the development of open innovation skills and competencies" and "empowerment of employees and their entrepreneurial mindset " and the range of open innovation modes a firm can handle both for inside-out and outside-in ties.

Table 4.9: Impact of internal organizing factors on outside-in open innovation practices (n=62)

	Outside-in	Inside-out
Factor 1: Support in the company		
Below median	3.093+	2.177
Above median	3.203	2.174
Factor 2: OI skills and competencies development		
Below median	2.850****	1.892****
Above median	3.466	2.487
Factor 3: Empowerment of employees and entrepreneurial initiative		
Below median	2.953 **	1.995 ***
Above median	3.356	2.361
Factor 4: Open innovation mindset		
	3.031	2.089
	3.251	2.270

Note: + Figures in the table are the averages on the three questions about innovation performance. Respondents could answer using a 5-point Likert scale (1= strongly disagree & 5= strongly agree)

* p<0.1
** p<0.05
*** p<0.01
**** p<0.001

We can draw two important conclusions from this section. First, companies that adapted their strategy and organizations to the specific requirements to open up their innovation process, have the ability to widen the range of open innovation modes, in order to strengthen their own innovation engine or to find external paths to market for their internally developed technology. In other words, companies can't consider how to team up with external partners without establishing the right strategy and internal organization to make this happen.

Second, not all strategic factors and organizational adaptations help to broaden the range of open innovation modes. If companies want to increase the diversity of ties with different external partners, they have to carefully check which parts of the strategy and internal organization are pivotal for accomplishing this job.

4.7. Open Innovation Maturity

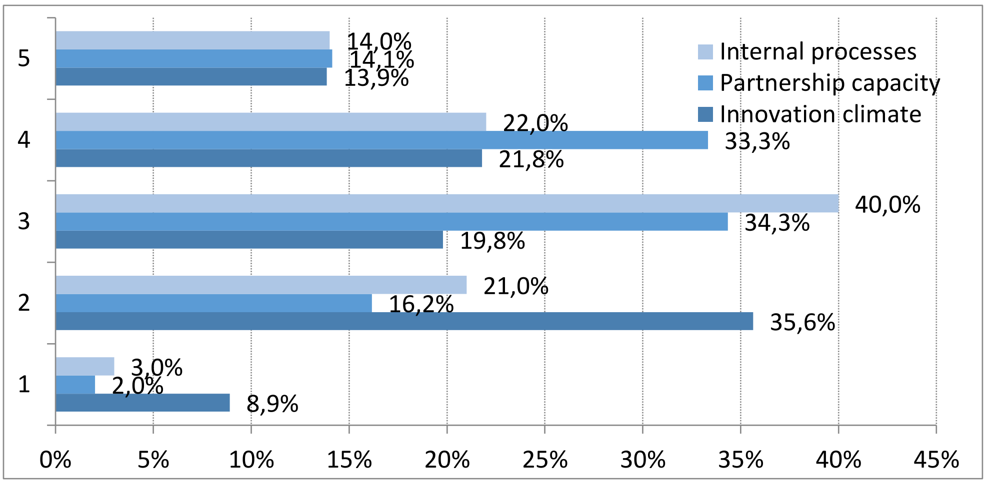
Open innovation maturity is a concept which managers consider as important to be successful in open innovation. Open innovation can't be implemented overnight and the larger the company the longer it usually takes before a truly open innovation mindset is established in the firm. Yet open innovation maturity has not received that much attention in the literature despite its importance according to practitioners. Therefor we introduced a separate section in the questionnaire about open innovation maturity, grounding are questions on the publication of Enkel, Bell and Hogenkamp (2011).

In order to successfully use open innovation, companies have to manage their organizational processes. The effectiveness of a process provides an indication of its maturity. Maturity in the context of software development is the "extent to which a specific process is explicitly defined, managed, measured, controlled, and effective". (Paulk et al., 1993:21). Enkel et al. (2011) apply this idea to the field of open innovation management and developed a framework for open innovation maturity in companies based on three pillars: *partnership capacity, climate for innovation* and *internal processes*. They define for these three pillars 5 maturity levels established as initial, repeatable, defined, managed, and optimizing. We used these three dimensions (or pillars) of open innovation to formulate three questions about open innovation maturity in the questionnaire. We copied the description of the 5 maturity levels per dimension (see Table 1 in

Enkel et al. (2014, 1173), rating maturity in this way from 1 to 5. Annex 3 provides the description of these 5 levels of maturity.

The answers of the respondents are presented in the following Figure. The means of the three pillars are 2.96 for innovation climate, 3.41 for partnership capacity, and 3.23 for internal processes. Respondents on average are thus confident about their maturity in partnership management. The maturity of internal processes supporting open innovation in the company comes second. The innovation climate has the lowest average score: this is not surprising since creating an open innovation climate throughout the entire company is a difficult target to achieve. The distribution of the scores for the three dimensions is shown in Figure 4.10.

Figure 4.9: Distribution of maturity levels for the 3 dimensions of Open Innovation maturity



The three dimensions are also highly correlated as represented in the following correlation table:

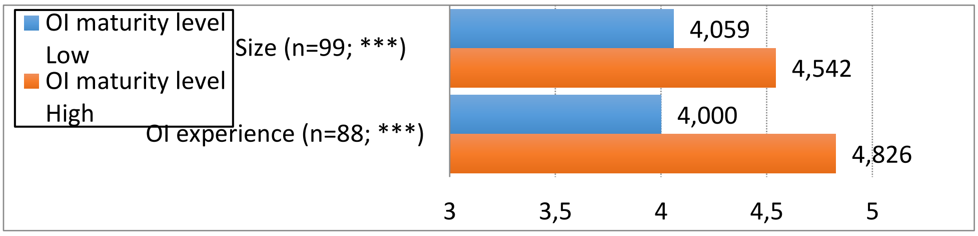
Innovation climate	1		
Partnership capacity	0.577	1	
Internal processes	0.635	0.567	1

This is not surprising as the maturity along one dimension goes hand in hand with the level of maturity on the other two. Developing maturity on only one or two pillars would be unbalanced and would render open innovation unsuccessful.

Open innovation maturity is related to the size of companies in our sample requires a long-term approach. (see requires a long-term approach.

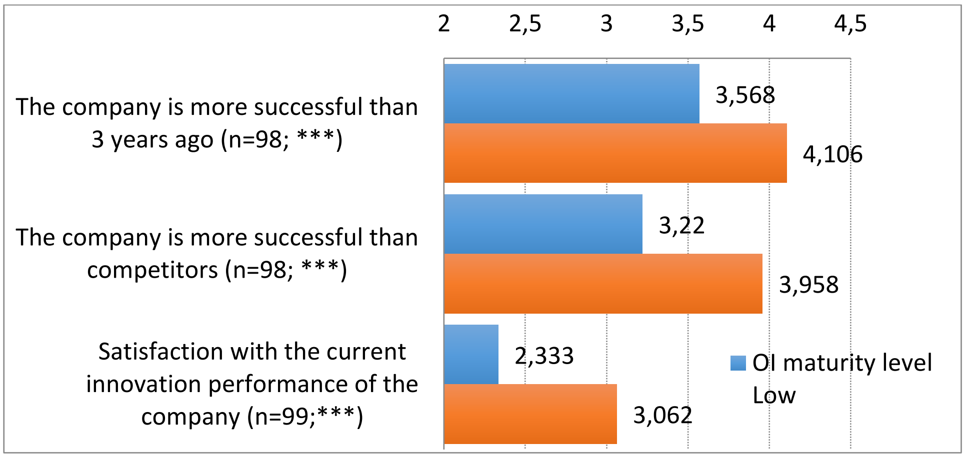
Figure 4.10) – open innovation maturity is calculated here as the average score on the three dimensions together. Larger firms have on average a higher open innovation maturity level. Not surprisingly, firms with longer experience in open innovation display a higher open innovation maturity: this indicates that open innovation takes time to mature in a company. Companies can't implement open innovation within the time span of 1 or 2 years. Developing an open innovation mindset requires a long-term approach.

Figure 4.10: Relationship between firm size, experience and Open innovation maturity



To show the importance of open innovation maturity we compare the average value of innovation success – measured in three different ways – of companies that have higher than median levels of open innovation maturity compared to those that have a lower than median levels of open innovation maturity (see Figure 4.11).

Figure 4.11: Relationship between open innovation maturity and innovation success



The results in the following table show that there is a strong relationship between open innovation maturity and innovation research. Firms need to grow and mature in their internal organization of open innovation before it can have a major impact on their innovation performance. It is a gradual process: firms can't expect immediate success from open innovation when they have been working in a closed innovation setting for years or decades.

4.8 Conclusions

The survey where this chapter on is based is intentionally designed to be a broad view of open innovation. This broad scope allows us to draw various conclusions on the topic, with the downside of not being able to dig deeper into any one specific topic. The wide net that was cast has given us some interesting findings. Our sample size consists mostly of large companies based in Europe who are mostly experienced in open innovation. It’s been discovered that open innovation starts in R&D intensive companies and is being taken up in less R&D intensive companies, showing us that open innovation is expanding. Additionally, the growth of open innovation is coming from smaller companies, further increasing its reach.

Open innovation is being primarily used to find new business opportunities, capabilities, and technologies, followed up by providing a window into proven and unproven technologies. This use of OI to expand the view of a company to effectively shorten the time to market is not surprising, however, it is interesting that large firms are interested in what OI can bring in terms of unproven technologies.

The findings discovered that outside-in is more used and more important than inside-out is also unsurprising. This is possibly due to the easier setup and less internal change needed to perform the former, however, the latter should be used more to monetize underused assets. These findings are in line with similar studies, which found that usage of OI is increasing, outside-in is more popular than inside-out, and it’s business motives which drive OI usage (Van de Vrande, 2009). However due to the differences in data and methodologies, deeper comparisons and insights cannot be determined.

A clear innovation strategy and structured innovation management process which integrates open innovation into the overall strategy can be seen as a competitive advantage. Organizationally, support for OI within the company is seen as key. The data has shown that there is a strong need for a robust innovation strategy, with communication internally and externally, and with OI support, to be successful in open innovation. However, the choice of strategy is important, as different strategies have various levels of impact on open innovation.

Open innovation maturity is a summary metric of how long and how deep open innovation efforts have been going on. This research has shown that higher levels of OI maturity leads to higher levels of success in open innovation. As maturity cannot be done overnight, this shows that a long commitment to open innovation is necessary for successful OI implementation. However, there has not been much study into OI maturity, which is needed, as maturity levels can provide an easy summary for senior managers to view.

This survey has shown that while open innovation is for most of our respondents an important part of their business, developing OI requires support from the top down, via an integrated innovation strategy, and bottom up, via support from the various internal departments. This is supported further by the OI maturity metrics, which shows that companies who have higher levels of maturity have more OI success. However, becoming more OI mature requires a sustained effort over time.

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Chapter 4 Endnotes

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i Primarily due to the Exnovate network, of which the respondents are a part of, being based in Europe

ii 1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always

iii For this exercise we dichotomized the factor loadings of the respondents. We considered firms that have a (lower) higher factor loading than the median as “relying (less) more on a specific factor”.

iv 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree

Annex 1: Survey

Below is the entire survey

Open Innovation Metrics

Part 1: Basic Information

1. What is the name of your company?

2. In what country is your headquarters located?

3. In what industry does your company operate? - If your company is in one industry, click and drag that industry into the grey box - If in multiple industries, click and drag the largest (by size of revenues) industry into the grey box, followed by the subsequent industries.

4. What is your job title?

5. What is your job function?

6. In what country are you primarily based?

7. What is the number of employees in the parent company?

Options

1 - 500

500 - 1000

1000 - 5000

5000 - 15000

>15000

8. What is the total worldwide sales volume last year in Euros?

Options

< 1 million

1 million - 25 million

25 million - 100 million

100 million - 500 million

500 million - 1 billion

1 billion - 5 billion

5 billion - 10 billion

10 billion - 50 billion

> 50 billion

9. Will you be answering the remainder of this Open Innovation survey speaking about your company as a whole or as a certain department / group / business line?

10. How long has Open Innovation been implemented in your organization?

Options

We have not implemented Open Innovation / Not Applicable

<1 year

1 - 3 years

3 - 5 years

5 - 10 years

> 10 years

11. Is Open Innovation used on continually in your company/ group?

Options

We continue to use Open Innovation at the same level

We have reduced the use of Open Innovation

We have stopped Open Innovation

We have not implemented Open Innovation in the past

Part 2: Success

12. How long ago did you company start reducing the usage of Open Innovation?

Options

< 1 year

1 - 3 years

3 - 5 years

> 5 years

Not Applicable

13. How long ago did you company stop using Open Innovation?

Options

< 1 year

1 - 3 years

3 - 5 years

> 5 years

Not Applicable

14. If your company continues to use Open Innovation, has the usage increased or stayed the same within the past 3 years?

Options

Stayed the same

Increased some

Increased dramatically

15. What is the name of your department / group / business line?

16. What is the number of employees in your department/ group/ business line?

Options

1 - 500

500 - 1000

1000 - 5000

5000 - 15000

> 15000

17. What is your approximate level of annual sales (in Euros) for your department or organization within the company in the last year? (if your department is a cost center, use your annual budget).

Options

< 1 million

1 million - 25 million

25 million - 100 million

100 million - 500 million

500 million - 1 billion

1 billion - 5 billion

5 billion - 10 billion

10 billion - 50 billion

> 50 billion

18. In what industry does your department / group / business line operate?

- If your group is in one industry, click and drag that industry into the grey box
- If in multiple industries, click and drag the largest (by size of revenues) industry into the grey box, followed by the subsequent industries.

19. What approximate percentage of your annual sales is spent on R&D?

Options

< 1 %

1 - 2 %

2 - 4 %

4 - 6 %

6 - 8 %

8 - 10 %

10 - 12%

12 - 14 %

> 14 %

20. What percentage of your revenue is spent on innovation in the last year?

Options

0 - 5 %

6 - 10 %

11 - 15 %

16 - 20 %

> 20 %

21. What percentage of patents are you actually using to create new products and services during the last 3 years?

Options

0 - 5 %

6 - 10 %

11 - 15 %

16 - 20 %

> 20 %

22. What percentage of your new product or services in the last 3 years included externally obtained knowledge?

Options

0 - 20 %

21 - 40 %

41 - 60 %

61 - 80%

81 - 100%

23. What is the success rate of a new product or service? ("A product or service is considered successful when it satisfies the company's expectations or when it stays on the market for 3+ years")

Options

0 - 20 %

21 - 40 %

41 - 60 %

61 - 80%

81 - 100%

24. What percentage of revenues is generated by products or services introduced in the last three years?

Options

0 - 5 %

6 - 10 %

11 - 15 %

16 - 20 %

> 20 %

25. What is the average time to market for your products or services

Options

1 - 2 years

2 - 3 years

3 - 4 years

4 - 5 years

> 5 years

26. Please answer the questions below regarding your innovation successes

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	N/A
In regards to innovation, my company/ group is more successful than three years ago.						
In regards to innovation, my company/ group is more successful when compared to competitors.						
I am satisfied with the current performance, in regards to innovation, within my company/ group.						

Part 3: Organizational Strategy

27. Please answer the questions below regarding organizational strategy

	How much do you agree?					How does this impact your innovation performance?			N/A
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Very little	Somewhat	A lot	
My company/ group has a strong innovation strategy relative to competitors.									
We innovate as fast as other companies.									
Innovation is managed throughout the company/ group (ie, there is a formal planning process, C-level approval, budget cycle, review procedure, substantial number of people have innovation targets)									
Both internal and external knowledge sharing takes place continuously and is well-supported by knowledge management									

processes.									
My company/ group has a clear view on how it wants to develop its product portfolio (ie, complete product roadmaps, identified areas to innovate, and necessary resources assigned)									
My company/ group evaluates innovation projects on false positives ("A R&D project that went entirely through the process, went to market through the company's business model and failed")									
My company/group evaluates innovation projects on false negatives ("A R&D project that does not fit in the company's business model, and is therefore not perceived as valuable to the firm but that becomes a success with another company's business model.")									
We always share our problems with all internal									

and external sources who are interested to solve the problems									
My company/group is effective in using external knowledge.									
In my company/group, there are regular discussions as to whether people are working effectively together									
In my company/group, objectives are modified in light of changing circumstances									

Part 4: Outside-In

28. Please answer the questions below regarding your Outside-In activities

	How often does it occur?					How does this impact your innovation performance?			N/A
	Never	Rarely	Some-times	Often	Always	Very little	Somewhat	A lot	
We collaborate with customers on innovation projects.									
We include knowledge from suppliers in the development process									
My company/group cooperates with universities.									
My company uses corporate venture capital (CVC) to invest in external start-ups ("CVC: Equity investments by established									

corporations in entrepreneurial ventures"; "Startup: a company with a limited operating history- they are usually newly created and ar									
My company/group uses crowdsourcing ("the act of taking a job that is traditionally performed by an employee and outsource it to an undefined, generally large group of people in the form of an open call")									
We use information intermediaries to find and use external ideas. ("Companies that help innovating companies to use external ideas more rapidly and to find markets where their own ideas can be used by others for mutual benefit")									
My company/group uses alliances to									

acquire additional knowledge.									
We use brainstorms and invite our entire network to join.									
My company/group licenses Intellectual Property (IP) from other companies.									
My company/group is open to license IP from beyond our industry									
We use a structured process when choosing our OI partners									
We have a structured OI partner selection process									

Part 5: Inside-out

29. Please answer the questions below regarding your Inside-out activities

	How often					How does this impact your innovatio			N/A

	Never	Rarely	Some-times	Often	Always	Very little	Somewhat	A lot	
My company/group uses external sales channels ("ways to put your product/service on the market via outside companies")									
My company/group uses corporate venture capital to create new companies out of underutilized technology.									
We use external venture capital to facilitate spin-offs ("Equity or equity-linked investments in young, privately held companies by groups of private investors")									
We license our Intellectual Property (IP) to other companies.									
We license our IP to everybody who									

wants to use our IP									
Our IP is protected via patents, copyright, and trademark and NOT trade secrets									
We license our IP as soon as we discover that we are not using it ("Use or Lose It" strategy)									
We work with information intermediaries to help sell/ distribute our IP									
We form alliances to exploit our knowledge									

Part 6: Mindset

30. Please answer the questions below regarding your company's mindset on Open Innvovation

	How much do you agree?					How does this impact your innovation performance?			N/A
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Very little	Somewhat	A lot	
My company/ group supports Open Innovation principles within my organization.									
My top management support the use of external ideas for Open Innovation.									
My legal department supports Open Innovation.									
My human resources department supports Open Innovation.									
My company/ group shares internally developed ideas with external sources.									

Corporate venture capital is managed well in my organization.									
My company/ group manages alliances well.									
There is a systematic training of people in OI.									
There is a dedicated OI team within the company/ group.									
"Not Invented Here Syndrome" does not exist in my company/ group (The syndrome that can be applied to companies who do not want to implement a technology that was not produced inside their company)									
"Not Sold Here Syndrome" does not exist in my company/ group (The syndrome that can be applied to companies who do not want to sell a									

product/ technology that was not produced inside their company)									
There is systematic knowledge sharing within my company/ group.									
In my company/ group, the management allows and empowers employees to take initiative and be entreprenurial									
In my company/ group, employees are willing to take initiative and be entrepreneurial									
My company/ group rewards Open Innovation activities									

Part 7: Deep Dive Questions

31. Do you have measures against 'Not Invented Here' syndrome? If so, please note them briefly in the comments section. (The syndrome that can be applied to companies who do not want to implement a technology that was not produced inside their company)

32. Do you have measures against 'Not Sold Here' syndrome? If so, please note

them briefly in the comments section. (The syndrome that can be applied to companies who do not want to sell a product/ technology that was not produced inside their company)

33. Does your company/ group have measures to stimulate the licensing/selling/releasing of technologies (inside-out)? (for example, P&G has a 3/5 program where after 3 years from first product ship or 5 years after patent issuance, the technology would be made available). If so, please complete below using one or more triggers. If no, please leave entire question blank.

34. Why do you use Open Innovation? (Check all that apply)

Options

Shorten time to market

To provide a window to novel (experimental / untested) technology

As a means of tapping into new (proven) technologies

To explore new capabilities and business opportunities

To apply existing capabilities and IP in new business opportunities or markets

To share risks and costs of innovations

Cheaper to use OI than traditional ways of doing business

Other (please comment below)

35. Does your company/ group have methods or metrics of measuring Open Innovation? If so, please list them in the box below. If no, please leave blank.

36. Where would you say your company/ group is in terms of maturity level for innovation climate? from Enkel, Bell, Hogenkamp, 2011.

- 1- little initiative taking; accidental opportunity spotting
- 2- verbal management support; informal success sharing;targets at lower levels;informal assessment;individual initiatives;arbitrary screening
- 3- written OI strategy;success sharing by management; targets based

on strategy;assessment partly OI based; champions appointed; screening by champions

- 4- strategy encouraged by management;regulated success sharing; targets set and communicated;champions awarded based on OI targets;champions encourage initiative taking;scouts assigned
- 5- management "walks the walk"; strategic success sharing;continuous adjustmentof targets; OI-based assessment; initiative taking in whole organization; wide focus on external opportunities

37. Where would you say your company/ group is in terms of maturity level for partnership capability? from Enkel, Bell, Hogenkamp, 2011.

- 1- Affection-based collaboration; arbitrary,one-off partnering,individual initiatives
- 2- few, informal, repeated partnerships; informal standardization, no plan;satisfy own organization; few, dominant forms;selection based on affection and experience; skills through experience
- 3- formal, low intense,short during partnerships; partial standardization;behavioural guidelines;diversity with few partners; previously used parties network;selection based on network experience;training through example setting
- 4- intensity, focus,endurance in partnerships; partnering tools used, clear ownership; management actively encourages satisfaction of partners; specific forms, diverse partners; diverse network expansion;strategy-based selection;training in partnering
- 5- variation intensity; both standardization and specification;satisfaction of partners monitored; diversity along value chain; inter-network linkages;selection criteria based on proactive strategy;sharing of partnership expertise

38. Where would you say your company/ group is in terms of maturity level for internal processes? from Enkel, Bell, Hogenkamp, 2011.

- 1- informal communication of initiatives; commitment based solely on friendships; knowledge not shared; individual absorption; no identification of results;protective legal and IP system
- 2- low level monitoring;limited sharing of facilities; reputation-based commitment; knowledge and information informally shared in team;

results thrown 'over the wall'; strict IP and legal conditions

- 3- Centralized reporting; regular meetings; opening facilities; on demand budget for meeting commitments; occasional inter-department knowledge sharing;absorption of knowledge actively encouraged; manager monitors progress; trust-based IP and legal attitude
- 4- linking initiatives;communication via intranet; start-up shared facilities; structural budget; project owners facilitate intra-organizational knowledge sharing; start process monitoring of results; long-term view of legal and IP
- 5- internal and external information gathering; contacting via central position; network facilities; OI integrated in budget; knowledge accessible in database; knowledge exploited in products; monitoring process in place; win-win contract

Annex 2: Metrics

When companies start to open up their innovation activities, it is mandatory to measure the efforts made and the impact they have on a firm's performance. This was an open question in the questionnaire. Some respondents indicated that their company uses open innovation metrics and have shared them with us (n=28). We have and categorized them as follows.

- Challenges/ crowdsourcing
  - Challenge programs and we have launched 21 challenges.
  - KPIs for use of open innovation challenges and participation in crowdsourcing tools
- Partnership count
  - In our research programs we measure the networking work (how many brainstorming sessions, workshops, seminars etc.) companies have
  - How many interested individuals / companies joining a new initiative / service
  - Number partners with high transformative potential
  - Number of contracts signed with 3rd parties
  - Number of external collaborations
  - Number of contracts signed with external parties for outside-in technology
  - Percentage product value from external sources
  - Strategic partners for our core technologies
  - Number of partners
- Employee related
  - R&D spend per employee
  - number of post-docs/talents employed and engaged into new product
  - number of part-time professors in our organization
- OI project count
  - Numbers of projects with external contribution
  - Number contribution of OI projects to Innovation Portfolio and Sales Figures
  - KPI on number of collaboration projects (of total pipeline projects)
  - number of open innovation projects
  - Percentage project containing
  - Percentage of innovation projects being done in OI
  - Reliance of projects on open innovation
  - Development of internal OI
  - Percentage of projects with universities and knowledge institutes;
  - Percentage of projects with customers, partners, or suppliers of our businesses
- Sales and speed to market
  - Speed to market
  - Sales from new products
  - Percentage of sales containing OI projects
  - turnover in millions of Euros resulting from OI projects
  - Impact of profit growth

- OI or Innovation or R&D spend/value
    - Percentage of spend on OI in relation to overall R&D and/or innovation budget
    - research and development expenses in millions of EUR detailed to innovation resulting from OI projects
    - value of OI projects vs. internal development baseline
    - Percentage of resources captured by OI initiatives
    - Amount of public funding (compared to budget)
    - Value of leverage from OI partners
    - Subsidy level obtained for next year (M€)
- Transfers of technology
    - Percentage of transfers accelerated by OI outside-in
    - Number of patents with third party inventors
- Intermediaries
    - specific KPIs for intermediaries
- Awards
    - Number of global innovation awards resulting from OI projects
    - Number of global design awards resulting from OI projects
- New Products
    - Percentage of new product development portfolio OI enabled
    - NPD & Research scorecard
    - Launch Data
    - Percentage of ideas approved by OI board and moved to market
    - Services development processes resulting from OI projects

Annex 3: OI Maturity

1. Where would you say your company/ group is in terms of maturity level for innovation climate? from Enkel, Bell, Hogenkamp, 2011.

- 1- little initiative taking; accidental opportunity spotting
- 2- verbal management support; informal success sharing;targets at lower levels;informal assessment;individual initiatives;arbitrary screening
- 3- written OI strategy;success sharing by management; targets based on strategy;assessment partly OI based; champions appointed; screening by champions
- 4- strategy encouraged by management;regulated success sharing; targets set and communicated;champions awarded based on OI targets;champions encourage initiative taking;scouts assigned
- 5- management "walks the walk"; strategic success sharing;continuous adjustmentof targets; OI-based assessment; initiative taking in whole organization; wide focus on external opportunities

2. Where would you say your company/ group is in terms of maturity level for partnership capability? from Enkel, Bell, Hogenkamp, 2011.

- 1- Affection-based collaboration; arbitrary,one-off partnering,individual initiatives
- 2- few, informal, repeated partnerships; informal standardization, no plan;satisfy own organization; few, dominant forms;selection based on affection and experience; skills through experience
- 3- formal, low intense,short during partnerships; partial standardization;behavioural guidelines;diversity with few partners; previously used parties network;selection based on network experience;training through example setting
- 4- intensity, focus,endurance in partnerships; partnering tools used, clear ownership; management actively encourages satisfaction of partners; specific forms, diverse partners; diverse network expansion;strategy-based selection;training in partnering
- 5- variation intensity; both standardization and specification;satisfaction of partners monitored; diversity along value chain; inter-network linkages;selection criteria based on proactive strategy;sharing of partnership expertise

3. Where would you say your company/ group is in terms of maturity level for internal processes? from Enkel, Bell, Hogenkamp, 2011.

- 1- informal communication of initiatives; commitment based solely on friendships; knowledge not shared; individual absorption; no identification of results;protective legal and IP system
- 2- low level monitoring;limited sharing of facilities; reputation-based commitment; knowledge and information informally shared in team; results thrown 'over the wall';strict IP and legal conditions
- 3- Centralized reporting; regular meetings; opening facilities; on demand budget for meeting commitments; occasional inter-department knowledge sharing;absorption of knowledge actively encouraged;manager monitors progress; trust-based IP and legal attitude
- 4- linking initiatives;communication via intranet; start-up shared facilities; structural budget; project owners facilitate intra-organizational knowledge sharing; start process monitoring of results;long-term view of legal and IP
- 5- internal and external information gathering; contacting via central position; network facilities; OI integrated in budget; knowledge accessible in database;knowledge exploited in products; monitoring process in place; win-win contrac

Annex 4: Principle Component Analysis

STRATEGY

Variable	Factor1	Factor2	Factor3	Factor 4	Description
v185	0.4793	0.4118			The company has a clear innovation strategy
v187	0.4613	0.5291			Innovation is managed in through a structured process
v188	0.3961	0.6917			Internal & extern knowledge sharing continuously takes & supported by a knowledge mgmt tool
v189	0.5920				The company has a clear view on how it develops its product portfolio
v190		0.4812	0.3374	0.6260	The company evaluates innovation projects on false positives
v191				0.8324	The company evaluates innovation projects on false negatives
v192	0.3523	0.3072	0.5059		Company's employees share problems w/ potential problems solvers, w/in & outside company
v194		0.7725			Regular evaluations in the company as to whether people are working together effectively
v195		0.7570			Objectives in the company are modified in the light of changing circumstances
v232	0.9069				The company uses a structured process when choosing OI-partners
v233	0.8846				The company has a structured process to collaborate with OI-partners
v267				0.795	Co's knowledge & tech protected via patents, copyrights & trademarks than trade secrets
v268			0.5954	0.3469	Co licenses IP as soon it is clear there is no internal use for tech ("Use it or loose it" strategy)
Variance Explained	33.2%	12.4%	9.6%	8.6%	

Note: - blanks represent abs(loading)<.03

Factor 1: A clear innovation strategy and structured open innovation management process.
Factor 2: Flexible adaptation of the innovation strategy based on continuous feedback on the effectiveness of internal and external collaboration
Factor 3: "Use it or loose it strategy" - strategy focused on valuing false negatives in innovation projects
Factor 4: Strategy based on legally protective mechanisms as an enabler for external use of technology

ORGANIZATION / MINDSET

Variable	Factor1	Factor2	Factor3	Factor4	Description
v290	0.8354				OI principles are supported in the company
v291	0.8558				Top management supports the use of external ideas for OI
v292	0.8458				The legal department supports OI
v293	0.7489				The human resources department supports OI
v294	0.6374				The company shares internally developed ideas with external organizations
v295		0.7700			Corporate venture capital is skillfully managed in the company
v296		0.6261			The company manages alliances skillfully
v297	0.3771	0.6988			There is a systematic training of employees in OI
v298		0.7578			There is an dedicated OI-team in the company
v299				0.9217	“Not invented here” syndrome doesn’t exist in the company
v300				0.7435	“Not sold here” syndrome doesn’t exist in the company
v301	0.4550		0.4815	0.3665	There is systematic knowledge sharing within the company
v302		0.3382	0.6695		Management allows and empowers employees to take initiatives and act entrepreneurial
v303			0.8986		Employees are willing to take initiatives and act entrepreneurial
v304	0.5713	0.4479	0.4135		OI activities are rewarded in the company
Variance Explained	37.0%	13.3%	9.2%	8.1%	

(blanks represent abs(loading)<.3)

Factor 1: Organizational and management support for OI in the company
Factor 2: OI skills / competencies development in the company
Factor 3: Freedom and empowerment of employees to take entrepreneurial actions in the company

Factor 4: Open innovation mindset among employees (internal and external knowledge sharing)

OUTSIDE-IN

Variable	Factor1	Factor2	Factor3	Description
v222	0.6251		0.3319	The company collaborates with customers on innovation projects
v223			0.8303	The company includes knowledge from suppliers in development projects
v224	0.5525			The company cooperates with universities
v225	0.4398	0.6932		The company directly or indirectly invests in start-ups (corporate venturing capital)
v226		0.8711		The company uses crowdsourcing to source ideas / technologies
v227		0.4717	0.6027	The company uses the services of intermediaries to find and use external ideas
v228	0.3437	0.3122		The company uses alliances to acquire external knowledge
v229		0.3186	0.6639	The company organizes brainstorm sessions and invites its external network to join
v230	0.6946			The company licenses intellectual Property (IP) from other companies
v231	0.8045			The company welcomes IP-licensing from organizations in other industries
Variance Explained	33.0%	12.1%	11.7%	

Note: - Blanks represent abs(loading)<0.3

Factor 1: Licensing from other organizations – is related to collaboration with universities, customers, start-up investments and alliances
Factor 2: Early stage sourcing of technological ideas and technologies via investments in start-ups and crowdsourcing
Factor 3: Supplier based knowledge sourcing (directly or intermediated)

INSIDE-OUT

Variable	Factor1	Factor2	Description
v262		0.8928	The company searches for external uses of internally developed innovations
v263	0.7114	0.4815	The company uses corporate venturing to create new companies using underutilized technology
v264	0.6929	0.4296	The company uses corporate venturing to set up spin-offs
v265	0.6866		The company out-licenses IP to other companies
v266	0.8031		The company licenses technology to everyone who wants to use the firm's IP
v269	0.7372		The company works with intermediaries to facilitate selling / distributing its IP
v270	0.6226		The company forms alliances to exploit internally developed knowledge
Variance Explained	47.4%	15.0%	

Note: blanks represent abs(loading)<.3)

Factor 1: An effective process to monetize on unused technology / knowledge

Factor 2: Active search for external uses of internally developed innovation through corporate venturing and spin-offs

Chapter 5. Open Innovation Training: The Key Link Between Entrepreneurial Culture, Open Innovation Support, and Firm Openness

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5.1 Introduction

In an increasingly competitive and saturated business scenario, firms need to generate relevant innovations if they want to remain financially sustainable and competitive (Sood and Tellis, 2005). That is why they are increasingly opening up to the outside world to capture external knowledge that can help improve and accelerate their innovation processes (Chesbrough, 2003; West and Bogers, 2017). Accordingly, the concept of open innovation (OI) has become a key topic in the innovation literature in recent years (e.g., Antons, Kleer, and Salge, 2016; Bogers, et al., 2017; Randhawa, Wilden, and Hohberger, 2016).

Whilst an extensive body of OI literature has examined the outcomes of firm openness, showing that openness to external partners can provide firms with a number of advantages, of which improved innovation performance is one of the most important (Laursen and Salter, 2006; Markovic and Bagherzadeh, 2018), the antecedents of firm openness have rarely been studied empirically (Bogers, Foss, and Lyngsie, 2018). This is at odds with recent studies showing some employee challenges and internal barriers that firms may face if they want to open up to the outside world and gather external knowledge for internal innovation processes (Alexy, Criscuolo, and Salter, 2012; Salter, Criscuolo, and Ter Wal, 2014).

More specifically, Alexy, Henkel, and Wallin (2013) showed that opening up organizational boundaries can create the following challenges for employees: changing job roles; facing different innovation cultures; experiencing communication problems with external partners; and dealing with the paradox of knowledge disclosure. These challenges are likely to limit employees' active efforts to establish points of contact with external partners, and thereby can hinder firm openness. Similarly, Salter et al. (2014) found that internal barriers, including the lack of a flexible structure for employees to interact with external partners, and a lack of employee skills and competencies to implement OI processes, can prevent firms from opening up their boundaries to capture external knowledge. Firms need to overcome these employee challenges and internal barriers to prevent them obstructing openness.

The OI literature suggests that an effective way to address the aforementioned employee challenges and internal barriers consists in developing an appropriate internal organization (Brunswicker and Vanhaverbeke, 2015; Chiaroni, Chiesa, and Frattini, 2011). Surprisingly, however, few empirical studies have examined how the firm's internal organization influences firm openness, and most of them are purely qualitative, case-based studies (e.g., Chiaroni et al., 2011; Salter et al., 2014). What previous research has established is that the firm's internal organization related to OI has three key dimensions: entrepreneurial culture (Cheng and Huizingh, 2014); OI support; and OI training (Lenz, Pinhanez, De Césaris, and Jacobs, 2016; Lichtenthaler and Lichtenthaler, 2009; Podmetina, Volchek, Dąbrowska, and Fiegenbaum, 2013).

In any firm, entrepreneurial culture involves allowing, empowering, and motivating employees to take initiative and entrepreneurial actions (Fogel, 2001). In relation to this dimension of internal organization, Hung and Chiang (2010) found that OI and entrepreneurial culture positively affect firm performance, and that they reinforce each other's effect, which implies that an entrepreneurial culture enables managers to benefit more from OI activities, making them more likely to open up the firm's boundaries. Scholars have also suggested that firms can only open up to the outside world effectively when they provide OI support. In other words, top management and the different functional departments (e.g., human resources, legal) must support OI activities taking place between the firm and its external partners (Lenz et al., 2016; Podmetina et al., 2013). Moreover, some researchers have argued that if firms want to go beyond their boundaries and collaborate effectively with external partners, they need to invest in OI training, by systematically training employees in OI and by establishing a dedicated team for coordinating and managing OI activities internally (Kirschbaum, 2005; Lichtenthaler and Lichtenthaler, 2009). Consequently, and building on individual-level absorptive capacity, which shapes the firm's overall absorptive capacity (Bogers et al., 2018; Cohen and Levinthal, 1990), it is plausible to expect that entrepreneurial culture, OI support, and OI training (i.e., the three key dimensions of the firm's internal organization related to OI) will increase employee ability to identify, assimilate and exploit external knowledge, and thus boost the firm's openness to external partners. Finally, some scholars have suggested that when employees are allowed, empowered and willing to take initiative and be entrepreneurial, top management and the different functional departments are likely to support them (Salter et al., 2014), provide them with systematic training to boost their OI-related skills and competencies, and create a dedicated team to coordinate and manage OI activities within the organization (Salter et al., 2014). Thus, it is reasonable to expect that entrepreneurial culture will boost OI support and OI training.

Subsequently, and in light of the aforementioned dearth of empirical, quantitative research examining the influence of internal organization (i.e., entrepreneurial culture, OI support, OI training) on firm openness (e.g., Chiaroni et al., 2011; Salter et al., 2014), this article examines empirically the influence of entrepreneurial culture on firm openness, considering the mediating roles of OI support and OI training. The article draws on a cross-industry sample of 104 firms engaged in OI. The data were collected from a survey of senior executives, and analyzed using a set of ordinary-least-squares (OLS) regression models and the bootstrapping procedure. The results show that entrepreneurial culture and OI support are not directly related to firm openness. Instead, OI training fully mediates the impacts of entrepreneurial culture and OI support on firm openness. Moreover, OI support partially mediates the relationship between entrepreneurial culture and OI training. These results imply that OI training is the key link between entrepreneurial culture, OI support, and firm openness. More specifically, without systematic OI training for employees and a dedicated team to coordinate and manage OI internally, entrepreneurial culture and support of OI principles and activities by top management and departments are not likely to result in greater firm openness to external partners.

In the following section, we describe the theoretical background and develop the hypotheses accordingly. Then, we present the methodology, data analysis, and results. Finally, we discuss the theoretical contributions, managerial implications, and limitations of this study and propose future research opportunities.

5.2 Theoretical Background and Hypothesis Development

5.2.1 The direct link between entrepreneurial culture and firm openness

In any firm, an entrepreneurial culture can provide employees with the freedom, empowerment and willingness to take initiative and entrepreneurial actions (Fogel, 2001) that can help the firm open up to the outside world (Keh, Nguyen, and Ng, 2007). The firm's recognition capacity (a component of absorptive capacity), conceptualized as the ability to identify and value external knowledge, is critical when firms want to open up to external partners (Cohen and Levinthal, 1990; Zobel, 2017). The firm's employees represent potential boundary spanners to identify external knowledge that may be valuable to OI processes (Bogers et al., 2018; Salter et al., 2014). Thus, firms need to ensure that employees have sufficient flexibility and freedom to establish points of contact with external partners to gather external knowledge effectively. Employees should have access to relevant and potentially valuable external knowledge, because they perform on the front lines of openness by bridging between the firm and its external partners (Salter et al., 2014). Identifying and valuing external knowledge is particularly critical in the context of firm openness, because it shapes the firm's overall recognition capacity (Bogers et al., 2018; Cohen and Levinthal, 1990), and thus active employee efforts to interact and establish relationships with external partners can be considered an important determinant of recognition capacity. Giving employees freedom and flexibility, and empowering them to take initiative and entrepreneurial actions by creating the right entrepreneurial culture can motivate employees to strengthen their relationships with external partners (Foss, Laursen, and Pedersen , 2011; Foss, Lyngsie, and Zahra, 2013; Gagné and Deci, 2005). These strengthened relationships with external partners can enable employees to grasp a wider range of external knowledge that can be used for internal innovation purposes (Ind, Iglesias, and Markovic, 2017). Moreover, these strengthened relationships between employees and external partners can allow the former to better understand and synthesize external knowledge (Faems, Janssens, Madhok, and Van Looy, 2008). By understanding and synthesizing external knowledge, employees can assess the fit between such external knowledge and the knowledge that the firm requires for its innovation projects (Zobel, 2017).

Overall, employees' capacity to recognize the relevant external knowledge can be improved by the firm's entrepreneurial culture, and firms that can access, value and synthesize the knowledge of external partners are more likely to open up their boundaries to organizational outsiders. Accordingly, in an empirical study of firms in diverse sectors and geographies, Ind et al. (2017) found that firms with an open, flexible and entrepreneurial organizational culture are more likely to be open to the outside world and to capture and use the ideas and knowledge of external stakeholders in their innovation processes. Likewise, in the context of online brand communities, Ind, Iglesias, and Schultz (2013) showed that organizations require an open, participatory and entrepreneurial leadership style and culture to work effectively with customers and capture the relevant customer insights and knowledge for innovation purposes. Similarly, based on a cross-industry sample, Keh et al. (2007) found that firms with entrepreneurially-supporting culture tend to interact with a great number of external partners to find and collect the knowledge they require. In line with this rationale, we hypothesize that:

H1. Entrepreneurial culture is positively related to firm openness.

5.2.2 The indirect links between entrepreneurial culture and firm openness: OI support and OI training

Even though giving employees freedom and flexibility and encouraging them to take entrepreneurial action can generate improved access to the knowledge of external partners, it can also create significant challenges in terms of working practices (Alexy et al., 2012; Salter et al., 2014). For example, Alexy et al. (2013) showed that, in a large telecommunications firm, opening up the software development process to external partners generates changes in both technical and administrative job tasks, and thereby creates challenges for employees. Similarly, based on a multiple case study of innovating companies, Salter et al. (2014) found that employees perceive interactions with external partners as secondary to internal knowledge sources, due to some challenges of working with external partners that include the paradox of knowledge disclosure. Thus, merely giving flexibility and freedom to the employees to take initiative and entrepreneurial actions is not sufficient to ensure that they will establish contact points with external partners and gather the knowledge of external partners effectively. In addition to giving employees flexibility and freedom, firms need to develop an OI-supportive corporate environment and a set of OI-related skills and competencies to cope with the aforementioned challenges that employees may encounter when interacting with organizational outsiders (Salter et al., 2014). This is important because these employee challenges tend to limit their active efforts to identify external knowledge that is relevant to the firm's innovation projects (Alexy et al., 2013; Salter et al., 2014). This can hinder the employees' capacity to recognize external knowledge, which may constrain the firm's overall recognition capacity (Zobel, 2017).

To help employees cope with the potential challenges of interacting with external partners, firms need to provide them with active support. More specifically, top managers need to support a set of openness principles and activities, such as working with appropriate people inside and outside the firm, valuing external research and development initiatives, and sharing information with external partners (Chesbrough, 2006; Salter et al., 2014). Moreover, functional departments (e.g., human resources and legal) need to provide employees with their professional support to resolve the challenges that openness can generate (Lund Vinding, 2006; Podmetina et al., 2013; Salter et al., 2014). This is especially important when facing challenges related to intellectual property rights and the paradox of knowledge disclosure (Jarvenpaa and Majchrzak, 2016; Laursen and Salter, 2014; Majchrzak, Jarvenpaa, and Bagherzadeh, 2015). On one hand, employees can feel the need to disclose some internal knowledge with external partners at an early stage of their interaction, to facilitate the process of identifying potentially valuable external knowledge (Bagherzadeh Niri, 2016; Jarvenpaa and Välikangas, 2014). On the other hand, employees may not be able to disclose any internal knowledge to the external partners before signing an agreement with them (Chesbrough, 2006). Thus, the legal department needs to provide employees with a clear policy about how much internal knowledge can be disclosed to potential external partners during initial interactions, before a formal agreement is in place (Salter et al., 2014).

Another factor that can make employees reluctant to interact with external partners is the lack of incentives and rewards for trying to identify relevant external knowledge and to establish contact and build innovation-oriented relationships with organizational outsiders (Foss et al., 2011; Podmetina et al., 2013). Thus, it is important for top management, and particularly the human resources department, to design an incentives system to reward employees that actively engage in the firm's openness process by successfully identifying external knowledge relevant to the firm's internal innovation activities (Podmetina et al., 2013).

In addition to giving organizational support in OI from top management and the different functional departments (i.e., OI support), firms should also establish a dedicated team for coordinating and managing OI activities within the firm and invest in developing employees' OI-related skills and competencies (i.e., OI training), as this is critical to tackling the different challenges that employees may face in the firm's openness process when interacting with organizational outsiders (Chatenier, Verstegen, Biemans, Mulder, and Omta, 2010; Kirschbaum, 2005; Lichtenthaler and Lichtenthaler, 2009). Accordingly, Podmetina et al. (2013), Salter et al. (2014) and Williams (2002) highlighted the fact that training employees is essential to provide them with the necessary skills (e.g., knowledge and technology scouting) to find potentially valuable external knowledge. Moreover, establishing a dedicated OI team in the firm can also help develop employees' OI skills and competencies (Chiaroni et al., 2011; Kirschbaum, 2005), and thus facilitate the process of identifying valuable external knowledge.

Overall, in spite of the fact that the firm's entrepreneurial culture can help employees to identify external knowledge, the openness process can put employees in uncertain, difficult situations if there is a lack of OI support and OI training. As argued above, organizational OI support and the development of employees' OI-related skills and competencies via OI training can enable employees to cope with such openness challenges. Thus, OI support and OI training can help employees to take more advantage of freedom and flexibility by working actively to identify the external knowledge relevant to internal innovation processes. Therefore, and in line with the previous research discussed above, we hypothesize that:

H2. Entrepreneurial culture is positively related to OI support.

H3. Entrepreneurial culture is positively related to OI training.

Although OI support and OI training may improve the employees' ability to identify relevant external knowledge, which is an important determinant of the firm's ability to open up to the outside world (Clausen, 2013; Lenz et al., 2016; Podmetina et al., 2013), identifying relevant external knowledge (i.e., recognition capacity) is not enough. Rather, it is only the starting point to firm openness. In addition to recognition capacity, Cohen and Levinthal (1990) suggested that assimilation and exploitation capacities (the other two components of absorptive capacity) are also important to ensure that the firm successfully internalizes and applies the identified external knowledge. After identifying the relevant external knowledge, firms need to analyze, process and diffuse it internally (i.e., assimilation capacity) (Zahra and George, 2002). Then, they need to determine how to apply it and combine it with internal knowledge (i.e., exploitation capacity) (Cohen and Levinthal, 1990; Zahra and George, 2002). Thus, employees need to transform external knowledge into forms that can be used internally, and find out how the firm can use it effectively to achieve its innovation goals (Zahra and

George, 2002). When employees have the required expertise in assimilating and integrating external knowledge, novel combinations of external and internal knowledge are likely to emerge (Cohen and Levinthal, 1990), which can incentivize firms to open up their boundaries to organizational outsiders. Thus, improving employee-level assimilation and exploitation capacities through OI training, as well as providing employees with OI support from top management and the different functional departments to overcome the obstacles to internalizing and integrating external knowledge, can improve the firm's overall absorptive capacity (Zahra and George, 2002; Zobel, 2017), and therefore the firm's willingness to open up its boundaries.

In this line, and based on a multiple case study on innovating companies, Salter et al. (2014) found that firms often pay little attention to the process of assimilating external knowledge. This discourages employees from actively engaging in the firm's openness process, as they are unable to see the value of external knowledge (Alexy et al., 2013), particularly when there is a poor perceived overlap between internal and external knowledge (Salter et al., 2014). Therefore, employee training and development programs become critical to teach employees the OI-related skills and competencies they need to assimilate and to exploit external knowledge (Clausen, 2013; Teirlinck and Spithoven, 2013). It is also crucial for firms to support employees in the openness process, for instance, by creating an OI assimilator role in the dedicated OI team (Chesbrough and Crowther, 2006; Salter et al., 2014). Such OI training and organizational OI support are likely to increase employee assimilation and exploitation capacities, which can in turn facilitate the process of internalizing and integrating external knowledge within the firm. Therefore, the firm can better realize the advantages of openness, and be encouraged to rely more on external knowledge by opening up organizational boundaries. In line with the above argument, we hypothesize that:

H4. OI training is positively related to firm openness.

H5. OI support is positively related to firm openness.

Providing employees with a systematic training in OI and creating a dedicated OI team to coordinate and manage OI activities requires an OI-supportive corporate environment (Salter et al., 2014). Thus, it is critical that the top managers not only recognize the value of OI initiatives but also embed them at the heart of the firm's strategies and internal organization (Hung and Chiang, 2010). In addition, top management should continuously allocate the financial and human resources required to support the development and implementation of OI initiatives and employee OI training (Salter et al., 2014). However, despite active support of OI by top managers, difficulties related to running OI training programs and establishing a dedicated OI team may emerge. For this reason, the functional departments (e.g., human resources and legal) also need to commit to the firm's dedicated OI team and to employee OI training by providing professional support. In fact, as successful OI initiatives require an up-to-date, wide-ranging set of skills and competencies (e.g., for negotiating, or for managing intellectual property rights), functional departments should strongly support and contribute to OI training and development programs and the establishment of a dedicated OI team (Chiaroni et al., 2011). Only if OI training is understood, shared and internalized by all functional departments will OI activities be carried out effectively, minimizing errors and avoiding the waste of resources. Overall, if the top management and the different functional departments provide support for OI activities, firms will be able to run the required employee OI training and development programs and establish a dedicated OI team. Following this rationale, we hypothesize that:

H6: OI support is positively related to OI training.

5.3 Methodology

5.3.1 Data collection and sample

We collected the data from surveys completed by senior executives (i.e., Chief Innovation Officers, Chief Technology Officers, R&D Directors, and OI Directors) affiliated to Exnovate - the European Network of Excellence on Open and Collaborative Innovation (www.exnovate.org), a non-for-profit organization through which OI practitioners can learn about OI and share best practices. The Exnovate network comprises approximately 7000 OI professionals, including practitioners, consultants, academics, policymakers, intermediaries, and OI associations, mostly located in Europe and the United States, almost one third of whom work in large companies that actively engage in OI.

We sent a first email invitation to a subset of 2234 OI practitioners. To increase the response rate, we divided the recipients into several waves, and sent reminder emails to non-respondents. Eventually, we received 160 responses. Some of these responses contained missing values for the key variables of this study, which reduced the final sample to 104 companies. To assess late-response bias, we conducted various statistical tests (i.e., ANOVA test, two-sample t-test, and chi-square test) to compare early and late respondents based on the variables related to firm characteristics. The results showed that there are no significant differences between early and late respondents in terms of firm openness, entrepreneurial culture, OI support, OI duration, innovation intensity, OI intensity, innovation performance, and industry groups. These results confirm the absence of late-response bias. 53.8% of the respondents work in manufacturing companies. The others work in various service industries, including professional services, wholesale, transportation, public utilities, finance, insurance, real estate, and retail. Agriculture and mining represents 3.9% of the respondents. Finally, most respondents (about 80%) are either innovation experts, active in the R&D department, or have senior-level management positions in their respective companies. This indicates that the respondents are suitable for our research objective. Table 5.1 portrays the distribution of the sample across industry groups, the respondents' job functions, and the sizes of the companies in terms of number employees.

Table 5.1. Sample characeristics by industry groups (based on SIC codes), respondent job functions, and firm sizes

Industry groups	%
Agriculture, Forestry, and Fishing	1.0
Mining	2.9
Manufacturing	53.8
Transportation and Public Utilities	2.9
Wholesale Trade	8.7
Retail Trade	2.9
Finance, Insurance, and Real Estate	4.8
Professional Services	23.0
Respondent job functions	**%**
Innovation, R&D, and technology experts	57.3
Management (senior level)	25.2
Other	17.5
Number of employees in 2013	**%**
1-500	16.3
500-1000	2.9
1000-5000	14.4
5000-15000	18.3
>15000	48.1

5.3.2 Measures

This study uses a set of perceptual measures to operationalize the constructs (i.e., latent variables) in our hypothesized model. We adopted the measures for entrepreneurial culture, OI support and OI training from the survey developed by Exnovate. The survey was developed with the objective to relate outside-in OI activities of firms to their internal organization. The survey included relevant scale items to measure the constructs in our study, and was designed to collect data from C-level managers, which made it suitable for our study. To refine the adopted measures, we conducted a first pretest with 30 MBA students, after which we improved their wording and usability. To further refine the measures, we conducted a pilot study with three OI practitioners.

5.3.3 Entrepreneurial culture, OI support, and OI training (Independent latent variables)

Entrepreneurial culture has to do with allowing, empowering, and motivating employees to take initiative and entrepreneurial actions. We measured this construct using the following two items: (1) In my company, the management allows and empowers employees to take initiative and be entrepreneurial; and (2) In my company, employees are willing to take initiative and be entrepreneurial. Respondents rated these two items on a five-point Likert scale, ranging from 1 "Strongly Disagree" to 5 "Strongly Agree."

OI support is related to the support of OI principles and activities by top management and the different functional departments, including human resources and legal. To measure it, we asked respondents to rank the following four items on a five-point Likert scale, between 1 "Strongly Disagree" and 5 "Strongly Agree": (1) My company supports Open Innovation principles within my organization; (2) My top management supports the use of external ideas for Open Innovation; (3) My legal department supports Open Innovation; and (4) My human resources department supports Open Innovation.

OI training has to do with providing employees with a systematic training in OI and creating a dedicated team to coordinate and manage OI activities within the organization. To operationalize it, respondents ranked the following two items on a five-point Likert scale, between 1 "Strongly Disagree" and 5 "Strongly Agree": (1) There is a systematic training of people in Open Innovation; (2) There is a dedicated Open Innovation team within the company.

5.3.4 Firm openness (dependent latent variable)

We measured the construct of firm openness as the extent to which a firm engages in outside-in OI activities (Bogers et al., 2018). Accordingly, we asked respondents how often each of the following five OI activities occurred (Chesbrough and Brunswicker, 2014): (1) My company uses crowdsourcing (the act of taking a job that is traditionally performed by an employee and outsource it to an undefined, generally large group of people in the form of an open call); (2) We use information intermediaries to find and use external ideas (companies that help innovating companies to use external ideas more rapidly); (3) My company uses alliances to acquire additional knowledge; (4) We use brainstorms and invite our entire network to join; and (5) My company licenses Intellectual Property (IP) from other companies. Respondents rated these five items on a five-point Likert scale, ranging from 1 "Never" to 5 "Always." The survey included a clear explanation of two relatively new OI activities (i.e., crowdsourcing and information intermediaries) to ensure that all respondents interpreted them correctly. As the main focus of this research is overall firm openness, we did not discriminate between different OI activities, and created a composite average measure of the above five items to measure the construct of firm openness.

5.3.5 Control variables

To avoid potential confounding effects, we controlled for two firm-level characteristics that can influence firm openness (Bogers et al., 2018). First, we controlled for firm size, using the number of employees as a proxy. Larger firms have more resources to invest in OI, which can affect firm openness. Thus, respondents indicated the number of employees in their company, based on five categories (see Table 1), and we included four dummy variables, the benchmark dummy being the largest category (>15000 employees). Second, to control for potential cross-industry differences related to firm openness, we included 7 dummy variables for 8 different industries in the model, based on Standard Industrial Classification (SIC) codes, defining the professional services industry group as the benchmark dummy.

5.4 Data Analysis

5.4.1 Construct analysis

To examine the factor structure of the items forming the independent latent variables, we first conducted an exploratory factor analysis (EFA) using SPSS 23.0. We applied principal component analysis (PCA) extraction and varimax rotation. Before conducting the PCA, we used Kaiser–Meyer–Olkin (KMO) to test for sampling adequacy, and applied Bartlett's sphericity test on the correlation matrix. Both tests yielded satisfactory results. The KMO value was 0.794, exceeding the recommended value of 0.6 (Kaiser, 1974) and Bartlett's test was significant (p-value < 0.001), indicating that PCA can be applied to investigate the factor structure. The results supported the three-factor structure of the items measuring the independent latent variables with a total explained variance of 76.39%, and all initial eigenvalues were greater than one. All items had factor loadings above the proposed threshold of 0.5 (Fornell and Larcker, 1981). Furthermore, all items loaded on the intended factor and there was no item cross-loading (see Table 5.2).

Table 5.2. Results of the EFA for the measurement scale of the independent latent variables

	Entrepreneurial culture	OI support	OI training
The management allows and empowers employees to take initiative and be entrepreneurial	**0.805**	0.230	0.164
Employees are willing to take initiative and be entrepreneurial	**0.877**	0.060	0.117
- My company supports OI principles within my organization	0.174	**0.780**	0.362
- My top management supports the use of external ideas for OI	0.240	**0.817**	0.208
My legal department supports OI	0.174	**0.840**	0.058
My human resources department supports OI	-0.033	**0.831**	0.154
There is a systematic training of people in OI	0.146	0.174	**0.862**
There is a dedicated OI team within the company	0.146	0.229	**0.858**
Eigenvalue	1.014	3.827	1.270
Percentage of variance explained	12.68	47.84	15.87

Note: Bold numbers indicate the greatest factor loading for each item.

Second, to test the three-factor structure and the convergent and discriminant validities of the independent latent variables, we conducted a confirmatory factor analysis (CFA) using the maximum likelihood method in AMOS 22.0. To assess goodness of fit, we used chi-square ($\chi 2$), goodness of fit index (GFI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). The results showed an acceptable fit for the three-factor structure (χ^2= 27.192 with *df* = 17 (χ^2/ *df* = 1.6); GFI = 0.941; CFI = 0.97; RMSEA = 0.076; SRMR = 0.043). All the fit indices were acceptable in terms of recommended cut-off values (Hu and Bentler, 1999).

Thereafter, we analyzed the factor loadings for the items (see Table 3). All standardized factor loadings were significant and greater than the suggested cut-off value of 0.50 (Fornell and Larcker, 1981). Moreover, all the average variance extracted (AVE) values were higher than the threshold value of 0.50 (Fornell and Larcker, 1981), supporting the convergent validity of all three independent constructs (i.e., entrepreneurial culture, OI support, and OI training). To check discriminant validity, we compared the square root of the AVE of each construct with the correlation of that construct with all other constructs. The square root of the AVE of each construct was higher than its correlation with all the other constructs. These results support the discriminant validities of all three independent constructs (Fornell and Larcker, 1981). Finally, we calculated composite reliability (CR) and Cronbach alphas to assess the reliability of the constructs (see Table 5.3). The CR values ranged from 0.70 to 0.87, and the Cronbach alphas from 0.67 to 0.87. This confirmed the reliability of the three independent latent variables (Nunnally and Bernstein, 1994).

Table 5.3. Results of the CFA for the measurement scale of the independent latent variables

Independent Latent Variables	Items	Standardized Loadings	Cronbach Alphas	CR	AVE [square root of AVE]
Entrepre-neurial culture	1) The management allows and empowers employees to take initiative and be entrepreneurial	0.846	0.67 (0.51)	0.70	0.540 [0.74]
	2) Employees are willing to take initiative and be entrepreneurial	0.603			
OI support	1) My company supports OI principles within my organization	0.885	0.87	0.87	0.633 [0.80]
	2) My top management supports the use of external ideas for OI	0.879			
	3) My legal department supports OI	0.717			
	4) My human resources department supports OI	0.679			
OI training	1) There is a systematic training of people in OI	0.736	0.75 (0.62)	0.77	0.623 [0.79]
	2) There is a dedicated OI team within the company	0.839			

Note: Pearson correlation coefficients are in parentheses.

5.4.2 Common method variance

This study may seem vulnerable to common method variance (CMV), as the data were collected from a single informant in each firm (Podsakoff and Organ, 1986). However, the dependent and independent latent variables were proximally separated in the questionnaire (Podsakoff, MacKenzie, Lee, and Podsakoff, 2003). Moreover, the hypothesized model includes indirect relationships between entrepreneurial culture and firm openness via OI support and OI training, making the model specification relatively complex. Thus, it is unlikely that respondents could have predicted the relationships between our latent variables when completing the survey. Therefore, CMV is not likely to be a problem in this study. Despite this, to test the possibility of the results being explained by CMV, we conducted the Harman's single-factor test (Podsakoff et al., 2003; Podsakoff and Organ, 1986). The test was based on CFA with the maximum likelihood method, and all the items related to the dependent and independent latent variables were set to load on a single factor. The results showed that the single-factor model did not provide an acceptable fit (χ^2= 110.323 with *df* = 27; GFI = 0.798; CFI = 0.782; RMSEA = 0.173; SRMR = 0.111). Thus, the CMV effect was not great enough to bias the results of this study.

5.4.3 Statistical methods

Table 5.4 shows the minimum and maximum values, means, standard deviations, and correlations of all constructs. An examination of the correlation between independent latent variables showed that multicollinearity is not a concern in this study. We also calculated the variance inflation factor (VIF) for the four constructs in all regression models. The VIF ranged between 1.139 and 1.749, indicating that multicollinearity is not a significant issue in the regression models. Then, we calculated the skewness and kurtosis values of all constructs to check their distribution. The results showed that all four constructs were normally distributed (skewness ranged from -0.792 to 0.160; and kurtosis from -1.093 to

0.979). In addition, the results showed that entrepreneurial culture was positively associated with firm openness (r=0.24 and p<0.05), and with both mediators – OI support (r=0.35 and p<0.001) and OI training (r=0.35 and p<0.001).

Table 5.4. Descriptive statistics of the constructs and construct correlations

	Min	Max	Mean	SD	1	2	3
1- Firm openness	1.2	4.8	2.90	0.74			
2- Entrepreneurial culture	1	5	3.57	0.86	0.24*		
3- OI support	1	5	3.76	0.88	0.34**	0.35**	
4- OI training	1	5	2.81	1.25	0.55**	0.35**	0.46**

* p<0.05, **p<0.001

To test the hypothesized model, we adopted the procedure suggested by Hayes (2013). We applied a set of ordinary-least-squares (OLS) regression models to estimate: (1) the effect of entrepreneurial culture on the two mediators OI support and OI training; (2) the impacts of both mediators on firm openness; (3) the direct influence of entrepreneurial culture on firm openness; and (4) the total effect of entrepreneurial culture on firm openness. Then, we estimated the indirect effect of entrepreneurial culture on firm openness through the mediators of OI support and OI training. To estimate the indirect effect, we calculated the product of regression coefficients from the above-mentioned estimations (1) and (2). To test the significance of indirect effects, we used the bootstrapping procedure (Shrout and Bolger, 2002), which is free of the normality distributional assumption for indirect effects. We used 5000 bootstrapping samples to calculate bias-corrected confidence intervals for the significance test (Mooney, Duval, and Duval, 1993). Before conducting all these analyses, we averaged the items of each latent variable to create single measures for each construct. We conducted all these analyses using SPSS 23.0, and tested the indirect effects using the PROCESS macro 2.16.1 (Hayes, 2013).

The normality distributional assumption in the OLS regression model was fulfilled, indicating that the OLS estimation is consistent. We checked the homoscedasticity assumption of the OLS regression by plotting the residuals against the predicted values of firm openness, entrepreneurial culture, OI support, and OI training. As we found no pattern in the plots, the homoscedasticity assumption was fulfilled.

5.5 Results

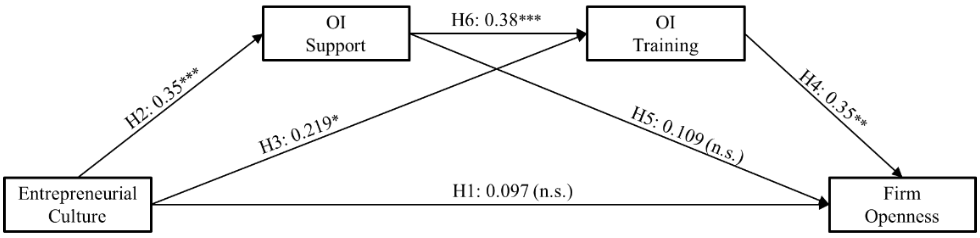
Our test of the hypothesized relationships showed that entrepreneurial culture is positively related to both OI support ($\beta = 0.35$, $p<0.001$) and OI training ($\beta = 0.219$, $p=0.019$), supporting hypotheses 2 and 3, respectively. OI support is also positively related to OI training ($\beta = 0.38$, $p<0.001$), supporting hypothesis 6 (see Table 5.5).

Table 5.5. Multiple regressions of the hypothesized relationships

	Outcome				
	Mediators		Firm openness		
Variables	OI support	OI training	Model I	Model II total effect	Model III direct effect
Mediators					
OI support		0.38*** (0.131)			0.109 (0.090)
OI training					0.35** (0.065)
Independent latent variable					
Entrepreneurial culture	0.35*** (0.095)	0.219* (0.134)		0.277** (0.081)	0.097 (0.088)
Control variables					
Number of employees					
1-500			-0.279* (0.276)	-0.297* (0.265)	-0.162 (0.263)
500-1000			-0.333** (0.419)	-0.312** (0.403)	-0.220* (0.393)
1000-5000			-0.213^{+} (0.231)	-0.175 (0.224)	-0.076 (0.217)
5000-15000			-0.326** (0.199)	-0.385*** (0.195)	-0.205^{+} (0.205)
Industry dummies			Yes	Yes	Yes
Intercept	2.477*** (0.349)	-0.372 (0.565)	3.417*** (0.246)	2.559*** (0.374)	1.948*** (0.410)
Δ R^2	0.122	0.25	0.221	0.069	0.101
Δ F-statistic	14.214***	16.875***	2.373*	8.789**	7.342**

Note: Standardized coefficients are reported. Standard errors are in parentheses.
Two-tailed test: $^{+}$ p<0.1; *p<0.05; **p<0.01; ***p<0.001

Figure 5.5. Estimated hypothesized model



Note: Standardized coefficients are reported.
Two-tailed test: *p<0.05; **p<0.01; ***p<0.001

Table 5.5 also presents the total and direct effects of entrepreneurial culture on firm openness. Some of the control variables and industry dummies have a significant effect on firm openness. Including entrepreneurial culture (Model II) added a significant explained variance (6.9% - ΔF=8.789, p=0.004). The results indicate that the total effect of entrepreneurial culture on firm openness is positive and significant (β=0.277, p=0.004). As shown in Table 5 (Model III), OI training latent variable is significantly and positively related to firm openness (β = 0.35, p=0.002), which supports hypothesis 4. The relationship between OI support and firm openness is not significant (β = 0.109, p = 0.305), and thus hypothesis 5 is not supported. Including the two mediators (i.e., OI support and OI training) to the model added a significant explained variance (10.1% - ΔF=7.342, p=0.001). The direct effect of entrepreneurial culture on firm openness was no longer significant (β = 0.097, p = 0.339), and thus hypothesis 1 is not empirically supported.

Thereafter, we estimated the three possible indirect effects of entrepreneurial culture on firm openness. As shown in Table 5.6, the second and third indirect effects are significant. Namely, entrepreneurial culture significantly influences firm openness via OI training (Indirect effect #III: β = 0.077; 95% CI

= [0.0104; 0.1633]) and following the path through OI support and then OI training (Indirect effect #II: β = 0.047; 95% CI = [0.0171; 0.0963]; 99% CI = [0.0097; 0.1165]). However, entrepreneurial culture does not have a significant effect on firm openness through OI support only (Indirect effect #I: β = 0.038, n.s. even at 90% confidence level = [-0.0116; 0.1047]).

Table 5.6. The indirect effects of Entrepreneurial culture on firm openness

Indirect effects	Standardized Coefficient	95% bootstrap CI
I) Entrepreneurial culture → OI support → Firm openness	0.038 (0.0356)	[-0.0232; 0.1184] +
II) Entrepreneurial culture → OI support → OI training→ Firm openness	0.047 (0.0174)	[0.0171; 0.0963] ++
III) Entrepreneurial culture → OI training → Firm openness	0.077 (0.0401)	[0.0104; 0.1633]

Note: The indirect effects are estimated based on the product of regression coefficients shown in Table 5 (the control variables were considered). Bias-corrected bootstrapping confidence intervals are based on 5000 bootstrapping samples. Bootstrapping standard errors are in parentheses.

+ 90% Bias-corrected bootstrapping confidence interval: [-0.0116; 0.1047].

++ 99% Bias-corrected bootstrapping confidence interval: [0.0097; 0.1165].

Overall, our results show that the relationship between entrepreneurial culture and firm openness is indirect. OI training fully mediates the impacts of both entrepreneurial culture and OI support on firm openness, and OI support partially mediates the relationship between entrepreneurial culture and OI training.

5.6 Robustness Analyses

To ensure that our results are robust in terms of analysis methods, we tested the statistical significance of the hypothesized relationships using structural equation modeling (SEM), with the maximum likelihood method, in AMOS 22.0. To assess goodness of fit, we used chi-square ($\chi 2$), GFI, CFI, RMSEA, and SRMR. The results showed an acceptable fit for the hypothesized structural model (χ^2= 35.522 with *df* = 22 (χ^2/ *df* = 1.62); GFI = 0.931; CFI = 0.965; RMSEA = 0.077; SRMR = 0.047). All fit indices were acceptable with regard to the recommended threshold values (Hu and Bentler, 1999). We developed alternative models (i.e., models 1, 2, and 4) to our hypothesized model (i.e., model 3), and calculated all their fit indices (see Table 5.7). Model 1 included the direct effects of entrepreneurial culture on both mediators, as well as the direct impacts of OI support and OI training on firm openness. Model 2 included the direct effects of entrepreneurial culture on OI support, OI training and firm openness, and the direct effects of both mediators on firm openness. As the $\chi 2$/df ratio of the hypothesized structural model (1.62) was lower than the $\chi 2$/df ratios of the alternative models 1 (1.93) and 2 (1.99), our hypothesized structural model fits the data better than alternative models 1 and 2. In addition, the GFI and CFI of the hypothesized structural model were higher than those of alternative models 1 and 2, and the RMSEA and SRMR of the hypothesized structural model were lower than those of alternative models 1 and 2 (see Table 7). Furthermore, we applied the chi-square difference test to compare our hypothesized structural model with alternative models 1 and 2. The hypothesized structural model is significantly better in $\chi 2$ than alternative model 1 ($\Delta\chi 2$ = 10.781, Δdf = 2, p-value = 0.005) and alternative model 2 ($\Delta\chi 2$ = 10.259, Δ*df* = 1, p-value = 0.001). Therefore, the hypothesized structural model (i.e., model 3) fits the data better than alternative models 1 and 2. The comparison between alternative model 2 and our hypothesized structural model shows the importance of the inclusion of the link between the two mediators (i.e., H6), as adding this link improves the model fit. Alternative model 4 reproduces the hypothesized model, but without the direct effect of entrepreneurial culture on firm openness. Not including this direct effect did not significantly change the fit indices found for model 3 (i.e., $\chi 2$/df ratio = 1.55 vs. 1.62; $\Delta\chi 2$ = 0.188, Δdf = 1, p-value = 0.665; GFI = 0.967 vs. 0.965; RMSEA = 0.073 vs. 0.077) and did not influence the path coefficients. This shows that including the direct effect of entrepreneurial culture on firm openness does not improve the model fit, which supports the results related to: (1) the full mediating effect of OI training in the relationship between entrepreneurial culture and firm openness; and (2) the mediated path from entrepreneurial culture to firm openness, through OI support and then OI training.

Table 5.7. Fit indices comparison between the hypothesized structural model and alternative models

	1 **E → S, T** **S, T → O**	**2** **E → S, T, O** **S, T → O**	**3** **Hypothesized structural model** **E→ S, T, O** **S→ T** **S, T → O**	**4** **Hypothesized structural model without direct link between E and O** **E → S, T** **S → T** **S, T → O**
χ^2 (df)	46.303 (24)	45.781 (23)	35.522 (22)	35.71 (23)
χ^2 /df	1.93	1.99	1.62	1.55
	p-value = 0.004	p-value = 0.003	p-value = 0.034	p-value = 0.044
GFI	0.911	0.911	0.931	0.931
CFI	0.942	0.941	0.965	0.967
RMSEA	0.095	0.098	0.077	0.073
SRMR	0.081	0.078	0.047	0.047

Note: E, Entrepreneurial culture; S, OI support; T, OI training; O, Firm openness

The results support four of the six hypothesized relationships (H1 and H5 are not supported) (see Table 5.8). We also applied the bootstrap procedure using 5000 samples, and calculated bias-corrected confidence intervals. Our results showed that the direct effect of entrepreneurial culture on firm openness is not significant ($\beta = -0.052$, $p = 0.666$, 95% Bias-corrected bootstrap CI = [-0.596; 0.291] – n.s. even at 90% confidence level = [-0.458; 0.222]), and therefore the first hypothesis is not empirically supported. Moreover, the effect of OI support on firm openness is not significant ($\beta = 0.083$, $p = 0.5$, 95% Bias-corrected bootstrap CI = [-0.152; 0.318] – n.s. even at 90% confidence level = [-0.111; 0.275]), which does not empirically support the fifth hypothesis. All the other hypotheses are empirically supported. Overall, we obtained the same results with a set of OLS regression models and with SEM, which shows that they are robust to different methods of analysis.

Table 5.8. SEM results of the hypothesized structural model

	Standardized Coefficients	Standard Error	p-value	95% Bootstrap CI	Result
H1: Entrepreneurial culture → Firm openness	-0.052	0.159	0.666	[-0.596; 0.291]	Not Supported +
H2: Entrepreneurial culture → OI support	0.483	0.202	<0.001	[0.26; 1.341]	Supported
H3: Entrepreneurial culture → OI training	0.245	0.300	0.082	[-0.066; 1.443]	Supported ++
H4: OI training → Firm openness	0.620	0.091	<0.001	[0.185; 0.638]	Supported
H5: OI support → Firm openness	0.083	0.108	0.5	[-0.152; 0.318]	Not Supported ++
H6: OI support → OI training	0.456	0.189	<0.001	[0.117; 1.033]	Supported

Note: Control variables were not included in the SEM analysis. Bias-corrected bootstrapping confidence intervals are based on 5000 bootstrapping samples.

+90% Bias-corrected bootstrapping confidence interval: [-0.458; 0.222] with p = 0.738.

++ 90% bias-corrected bootstrapping confidence interval: [0.035; 1.24] with p = 0.081.

+++ 90% Bias-corrected bootstrapping confidence interval: [-0.111; 0.275] with p = 0.497.

As this paper focuses on the linear relationship between entrepreneurial culture and firm openness, we must ensure that there is no curvilinear association between these latent variables. To do so, we added the square values of entrepreneurial culture to the model. The model fit remained the same (ΔR^2=0.001, F change=0.106, p=0.746) and we found a non-significant coefficient for the squared term, supporting the linear relationship between entrepreneurial culture and firm openness.

As this article also studies the mediating effects of OI support and OI training in the relationship between entrepreneurial culture and firm openness, we tested their potential moderating effects by adding two interaction terms to the model. To avoid the potential multicollinearity generated by adding the squared and interaction terms, we centered the values of all three independent latent variables, on their means before multiplying. The model fit remained the same for the OI training interaction term ($\Delta R^2=0$, F change=0.003, p=0.958) and for the OI support interaction term ($\Delta R^2=0.001$, F change=0.160, p=0.685). We found no significant moderating effects, confirming the mediating effects of OI support and OI training.

To ensure that the effects of entrepreneurial culture and the two mediators on firm openness are not confounded, we controlled for the duration of OI in the firm, which can affect firm openness regardless of entrepreneurial culture, OI support, and OI training. Respondents answered the question "how long has open innovation been implemented in your organization?" based on five categories (< 1 year, 1 - 3 years, 3- 5 years, 5 - 10 years, and >10 years), of which the last was defined as the benchmark dummy. We added four dummy variables to control for the duration of OI. There was one missing value for this variable, which reduced the sample to 103 firms. We found no significant changes in the impact of entrepreneurial culture (β=0.086, p=0.396), OI support (β=0.084, p=0.447), and OI training (β=0.322, p=0.005) on firm openness. Moreover, we identified no substantial changes in the indirect effects (indirect effects #II and #III were significant at 95% confidence level and indirect effect #I was not significant even at 90% confidence level) of entrepreneurial culture on firm openness. We also controlled for the intensity of outside-in OI activities over the last three years, measured by "the percentage of new products or services in the last 3 years including externally obtained knowledge." We added four dummy variables to the model, as respondents were provided with five categories (0-20%, 21-40%, 41-60%, 61-80%, and 81-100%), the last of which was the benchmark dummy, to indicate outside-in OI intensity. With this variable, the sample size fell to 95 firms, due to missing values. We found the same results for all hypotheses, and there were no significant changes in the indirect effects (indirect effect #II was significant at 95% and #III was significant at 90% confidence level, #I was not significant even at 90% confidence level). These findings show that our results are not confounded by these two firm-level variables, and confirm their robustness.

Another concern in this study is the potential endogeneity of entrepreneurial culture and firm innovation climate maturity level, which can inflate the relationship between entrepreneurial culture and firm openness. Maturity can influence the level of entrepreneurial culture, and simultaneously affect firm openness. To control for this potential endogeneity problem and the fixed effects of maturity, we measured innovation climate maturity level based on a five-point Likert scale developed by Enkel, Bell and Hogenkamp (2011) (see Appendix 1). With this variable, the sample size fell to 102 firms due to missing values. We found the same results for all hypotheses, and there were no significant changes in the indirect effects (indirect effects #II and #III were significant at 95% confidence level, indirect effect #I was not significant even at 90% confidence level), supporting the robustness of our results.

5.7 Discussion and Conclusion

5.7.1 Theoretical contributions

Scholars and practitioners have studied OI in detail over the last decade (e.g., Bogers et al., 2017; Randhawa et al., 2016), as firms have increasingly used both internal and external knowledge to improve their innovation processes (Brunswicker and Chesbrough, 2018). An extensive body of OI literature has studied the advantages that firms can obtain by opening up to external partners, of which improved innovation performance is one of the most important. Despite such studies showing that the firm openness plays a decisive role in achieving innovation success, the antecedents of firm openness have rarely been studied empirically (Bogers et al., 2018). In addition, recent studies have identified employee challenges (i.e., changing job roles, facing different innovation cultures, experiencing communication problems with external partners, and dealing with the paradox of knowledge disclosure) and internal barriers (e.g., the lack of a flexible structure for employees to interact with external partners, the lack of employee skills and competencies to implement OI processes) that firms may face if they want to open up to the outside world and gather knowledge from external partners (Alexy et al., 2012; Salter et al., 2014). If these employee challenges and internal barriers are not properly managed, they can counteract the staff efforts to interact and form innovation-oriented relationships with external partners. This may prevent firms from opening up to the knowledge available in the outside world. Therefore, it is crucial for firms to support employees by developing an appropriate internal organization helping them to interact with external partners (Brunswicker and Vanhaverbeke, 2015; Chiaroni et al., 2011). Surprisingly, however, few empirical studies have examined how internal organization influences firm openness, and most of these are purely qualitative, case-based studies (e.g., Chiaroni et al., 2011; Salter et al., 2014). To fill this gap, our study has examined how internal organization influences firm openness to external partners, focusing on the three key dimensions of internal organization that relate to the OI process (i.e., entrepreneurial culture, OI support, and OI training) and adopting a quantitative research methodology.

First, our study contributes to the literature by showing that the creation of an entrepreneurial culture is not enough to increase firm openness. This means that not only by allowing, empowering and motivating employees to take initiative and entrepreneurial action, firms are going to be more open to the outside world and capture the knowledge of external partners for internal innovation purposes. Instead, our study shows that firms need first to provide their employees with systematic OI training and create a dedicated OI team. This emphasizes the key role of OI training in turning employees who are empowered and willing to take initiative and entrepreneurial action into employees who interact effectively with external partners to capture their knowledge.

Second, our study contributes to the literature by finding that OI support does not directly boost firm openness. This means that not only by supporting OI principles and activities at the top management level and across the different functional departments of the organization (e.g., human resources, legal), firms are going to open themselves up to the outside world and gather external knowledge for internal innovation processes. Rather, our research shows that OI support needs first to result in improved OI training. That is, the whole organizational structure should first facilitate systematic OI training for employees and the development of a dedicated team to coordinate and manage OI internally.

Although developing a dedicated OI team is a standard practice in companies, it has not received a lot of attention from OI scholars so far (Podmetina et al., 2013).

Overall, our study is genuine in showing that OI training is the key link between entrepreneurial culture, OI support, and firm openness. Without investing in OI training, firms are unlikely to benefit from an entrepreneurial culture and OI support. More specifically, without ensuring systematic OI training for employees and developing a dedicated OI team, entrepreneurial efforts by employees, and support for OI principles and activities by top management and departments, are not likely to result in greater firm openness to the knowledge of external partners. Finally, by showing the importance of OI training in the influences of both entrepreneurial culture and OI support on firm openness, our study builds empirically on the literature on individual-level absorptive capacity (Bogers et al., 2018; Cohen and Levinthal, 1990). We suggest that by systematically training employees in OI and developing a dedicated OI team, employees can improve their ability to recognize, assimilate and exploit external knowledge for internal innovation purposes, and thereby improve the firm's overall absorptive capacity and openness to the external world.

5.7.2 Managerial Implications

This study has several implications for managers interested in opening up their firms to the outside world and capturing external knowledge to improve their internal innovation processes. Managers should first understand that, to increase firm openness, it is not enough (1) to allow, motivate and empower employees to take initiative and be entrepreneurial (i.e., develop an entrepreneurial culture) and (2) to support OI principles and activities at organizational and departmental level (i.e., develop OI support). They also need to invest in OI training. That is, managers should ensure that they provide their employees with systematic training in OI and create a dedicated team to coordinate and manage OI internally, if they want their entrepreneurial culture and OI support to result in improved firm openness. Providing such OI training is likely to help employees cope with the challenges of interacting with external partners, such as changing job roles, facing different innovation cultures, experiencing communication problems, and dealing with the paradox of knowledge disclosure.

To ensure that employees interact with external partners and capture their knowledge effectively, managers should align the firm’s human resources policies and practices with its OI strategy. This means that they should implement recruitment and promotion policies and practices that encourage openness to external partners. To achieve this, manages should concentrate on recruiting, training, and promoting employees with high OI-related skills and competencies (i.e., interactional and relational skills and competencies) who can effectively recognize, assimilate and exploit the knowledge of external partners (i.e., employees with high absorptive capacity). Employees with high absorptive capacity are crucial to innovative firms, because by spreading the absorbed external knowledge across the firm’s different departments and combining it with internal knowledge, they can help boost the firm’s innovation performance and competitive advantage (Foss et al., 2011; Markovic and Bagherzadeh, 2018).

5.7.3 Limitations and future research

Notwithstanding its theoretical contributions and managerial implications, this study also has several limitations. First, the survey is cross-sectional. The cross-sectional design prevented us from examining causal relationships adequately. A comprehensive test of causality requires longitudinal and/or experimental designs: this could be an important next step for this line of research.

Second, as different OI mechanisms require different types of OI support and OI training to be effective, a detailed analysis of the interaction between each OI mechanism and the different types of OI support and OI training would be required to improve the understanding of the antecedents of firm openness. For such a detailed analysis, future research could use project-level datasets to investigate specific outside-in OI mechanisms, and the different types of OI support and OI training that are required in each specific innovation project.

Third, as we collected the data from a single respondent in each firm, this research is vulnerable to CMV. Although the dependent and independent latent variables were proximally separated in the questionnaire, and although our hypothesized model contained rather complex relationships, we did also tackle the CMV issue by applying the Harman single-factor test, and concluded that the CMV was not great enough to bias the results of our study. Ideally, however, future research should take a multi-source approach (e.g., collecting data for the independent and dependent latent variables from two respondents) to circumvent the CMV problem entirely.

In addition to addressing these limitations, our study suggests other interesting avenues for future research. First, OI readiness has so far been studied through qualitative research (e.g., Chiaroni et al., 2011; Enkel et al., 2011) that draws heavily on in-depth interviews and case studies. Such methods are welcome to chart relatively new phenomena and to develop theories (Eisenhardt, 1989), but quantitative research methods should be applied to generalize research outcomes and test hypotheses. Second, one drawback of surveys is that the data are self-reported, and thus subjective. Objective data and measures are needed to relate internal organization (i.e., entrepreneurial culture and observable OI support and OI training) to the incidence of OI activities. This, in turn, requires the systematic measurement of internal organization and OI activities in companies, and standardized measures to make them comparable across firms and industries.

Appendix 1: Items for firm innovation climate maturity

Where would you say your company is in terms of maturity level for innovation climate?

1. Little initiative taking; accidental opportunity spotting
2. Verbal management support; informal success sharing; targets at lower levels; informal assessment; individual initiatives; arbitrary screening
3. Written OI strategy; success sharing by management; targets based on strategy; assessment partly OI based; champions appointed; screening by champions
4. Strategy encouraged by management; regulated success sharing; targets set and communicated; champions awarded based on OI targets; champions encourage initiative taking; scouts assigned
5. Management "walks the walk"; strategic success sharing; continuous adjustment of targets; OI-based assessment; initiative taking in whole organization; wide focus on external opportunities

Chapter 5 References

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Chapter 6. How Does Outside-In Open Innovation Influence Innovation Performance? Analyzing the Mediating Roles of Knowledge Sharing and Innovation Strategy

Table of Contents for Chapter 6

6.1 Introduction

In an increasingly competitive business environment, firms can gain competitive advantage when they create relevant product and/or service innovations (Ind et al., 2017; Mostafa, 2016; Sood & Tellis, 2005). In accordance with the open innovation (OI) model (H. Chesbrough, 2003c; J. West, Vanhaverbeke, & Chesbrough, 2006), firms can improve their innovation potential by purposefully going beyond their boundaries using inflows of knowledge in their innovation processes (i.e., outside-in OI) . The literature has identified several outside-in OI mechanisms, including alliances (Faems et al., 2008), OI intermediaries, crowdsourcing (Afuah & Tucci, 2012), and in-licensing agreements (Li-Ying & Wang, 2015), and argued that embracing outside-in OI can result in a multitude of advantages, such as greater access to external knowledge, shared risk with partners, better understanding of customer needs, and improved innovation performance (H. Chesbrough, 2003c; Du et al., 2014; Foss et al., 2013; Laursen & Salter, 2006).

Although some empirical studies have shown that outside-in OI boosts innovation performance (Cheng & Huizingh, 2014; Du et al., 2014; Faems et al., 2008; Laursen & Salter, 2006; Salge, Farchi, Barrett, & Dopson, 2013), others have found that it has no effect on innovation performance, or even a negative effect (Caloghirou, Hondroyiannis, & Vonortas, 2003; Campbell & Cooper, 1999; JH Dyer, Powell, Sakakibara, & Wang, 2006; Knudsen, 2007; Knudsen & Mortensen, 2011; Lhuillery & Pfister, 2009; Un, Cuervo-Cazurra, & Asakawa, 2010). Moreover, scholars have found cases of failed outside-in OI projects, where firms did not achieve their predefined innovation performance objectives (Arino & De La Torre, 1998; De Rond & Bouchikhi, 2004; Majchrzak et al., 2015).

This mixed empirical evidence leads to confusion about how firms can attain a better innovation performance by embracing outside-in OI. One reason why previous research has obtained mixed findings may be differences between firms' internal practices for managing innovation processes, because tapping into external knowledge creates a set of managerial challenges (Brunswicker & Vanhaverbeke, 2014; Chiaroni et al., 2011; Foss et al., 2011; Salter et al., 2014). One of these managerial challenges is to ensure that employees have an accurate understanding of the firm's knowledge needs to be able to identify and value relevant external knowledge (Foss et al., 2011). Another managerial challenge is to make sure that the relevant external knowledge is in a form that can be used internally, and is transferred to the appropriate business units and departments (Salter et al., 2014). These challenges highlight that firms may need to introduce a set of internal practices when engaging in outside-in OI to increase the probability of innovation performance improvement. This implies that internal practices may mediate the relationship between outside-in OI and innovation performance (Abell et al., 2008; Felin, Foss, & Ployhart, 2015; Foss et al., 2011). Surprisingly, however, most previous studies have only directly related outside-in OI to innovation performance (Du et al., 2014; Faems et al., 2005; Laursen & Salter, 2006; Salge et al., 2013), and to the best of our knowledge, only Foss et al. (2011) have considered internal practices as a mediator of such relationship. However, while Foss et al. (2011) have provided empirical evidence for a positive indirect effect of outside-in OI on innovation performance through internal practices, they have only included one type of external partners (i.e., customers) in the analysis. Thus, this article aims at unpacking the relationship between outside-in OI and innovation performance to analyze how firms can turn outside-in OI into improved innovation performance through internal practices, considering a wider range of external partners.

In the field of OI, there is some evidence showing that knowledge sharing and a clear innovation strategy, which are two types of internal practices, are essential when firms want to transfer outside-in OI into improved innovation performance (Brunswicker & Vanhaverbeke, 2014; Foss et al., 2011; Huizingh, 2011; Majchrzak et al., 2015). On one hand, knowledge sharing between firms and external partners is likely to increase a firm’s capability to identify and value different areas of knowledge that are relevant to the innovation process, and to assimilate and exploit the absorbed knowledge effectively, thereby boosting innovation performance (Doz, 1996; Hardy, Lawrence, & Grant, 2005; Majchrzak et al., 2015). For example, Faems et al. (2008) found that, in the case of strategic alliances, a lack of knowledge sharing between the partnering firms slows innovation activity, leading to an unsuccessful performance outcome. In addition, several scholars have argued that sharing knowledge inside firms - among internal business units and employees - helps the assimilation and exploitation of external knowledge during innovation processes, which in turn leads to increased innovation performance (Foss et al., 2011; Zobel, 2017). On the other hand, a clear innovation strategy, as a formal statement indicating innovation areas, roadmaps and required resources, determines the scope and direction of external search, which in turn enables firms to identify the required knowledge that is relevant to their innovation activity (Chiaroni et al., 2011). Likewise, the innovation strategy helps firms to assess the fit between external knowledge and internal innovation needs, thereby ensuring enhanced innovation performance (H. Chesbrough & Crowther, 2006; Chiaroni et al., 2010, 2011). Moreover, having an innovation strategy with a formal planning process, a budget cycle, and a review procedure, can improve the internal coordination and synchronization of external knowledge (Zobel, 2017). This can facilitate the assimilation and exploitation of absorbed knowledge from external sources, and thereby boost innovation performance (Zobel, 2017).

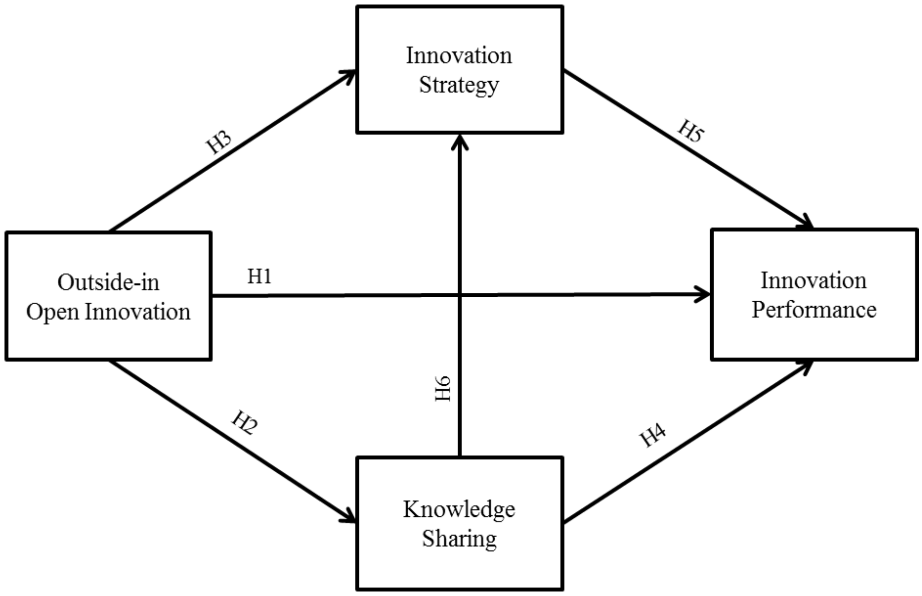
As knowledge sharing, inside firms and between firms and external partners, and innovation strategy are internal practices that are closely related to the outside-in OI process (Brunswicker & Vanhaverbeke, 2014; Foss et al., 2011; Huizingh, 2011; Majchrzak et al., 2015) and that can boost innovation performance (Foss et al., 2011; Lakemond, Bengtsson, Laursen, & Tell, 2016), this paper studies them as potential mediators of the relationship between outside-in OI and innovation performance, to overcome the above-discussed differences in understanding of how firms can take advantage of outside-in OI. The paper draws on a cross-industrial sample of 112 firms that are active in OI. Data were collected via a survey of senior executives, and analyzed using a set of ordinary-least-squares (OLS) regression models and the bootstrap procedure. Results show that outside-in OI is not directly related to innovation performance. Instead, this relationship is fully mediated by knowledge sharing and innovation strategy. On one hand, this means that to translate outside-in OI into improved innovation performance, firms need to constantly and systematically share knowledge within and beyond their boundaries. On the other hand, this implies that firms need to develop an innovation strategy that makes innovation areas and required resources clear, and that establishes a formal planning process to obtain the same result. Consequently, this study makes a twofold contribution to the field of OI. First, it shows that engaging in outside-in OI activities is not sufficient to guarantee an improvement in innovation performance. Second, it shows that outside-in OI can turn into improved innovation performance through the internal practices of knowledge sharing and innovation strategy, which helps explain why some outside-in OI activities are successful and others are not.

The following sections of the paper present the theoretical background and hypotheses development, the methodology, the data analysis, the results, and the discussion and conclusion.

6.2 Theoretical Background and Hypotheses Development

The hypothesized relationships between outside-in OI, knowledge sharing, innovation strategy and innovation performance are represented by the six arrows in Figure 6.1. In this section, we discuss: (1) the impact of outside-in OI, knowledge sharing and innovation strategy on innovation performance (i.e., H1, H4 and H5 – see Table 6.4, Models III, IV, and V); (2) the effect of outside-in OI on knowledge sharing and innovation strategy (i.e., H2 and H3 – see Table 6.4, Models I and II); and (3) the impact of knowledge sharing on innovation strategy (i.e., H6 - see Table 6.4, Model II).

Figure 6.1. Hypothesized model



6.2.1 The direct link between outside-in OI and innovation performance

Outside-in OI consists of purposefully using the ideas, skills and knowledge of a wide range of external partners (e.g., customers, suppliers, universities, competitors) to accelerate internal innovation processes (H. Chesbrough, 2006b). To access the ideas, skills and knowledge of their external partners, firms can use various mechanisms, including alliances, OI intermediaries, crowdsourcing, and in-licensing agreements (Afuah & Tucci, 2012; Henry Chesbrough & Sabine Brunswicker, 2014; Faems et al., 2008; Li-Ying & Wang, 2015; Malhotra & Majchrzak, 2014).

Collaborating with external partners can give firms easier access to valuable external ideas, skills, and knowledge (Jeffrey Dyer & Singh, 1998). In accordance with the resource-based view, extended to the collaboration of firms with external partners (Eisenhardt & Schoonhoven, 1996; Lorenzoni & Lipparini, 1999), this access to valuable external ideas, skills and knowledge allows firms to improve internal innovation activities by including previously inaccessible resources. In that sense, outside-in OI improves the quantity, quality and diversity of ideas, skills and knowledge, and thereby complements existing internal resources and capabilities (Barney, 1991; Eisenhardt & Schoonhoven, 1996). This provides firms with the opportunity to improve their innovation capabilities, which can result in improved innovation performance (Faems et al., 2005; Salge et al., 2013; Zobel, 2017).

Collaborating with external partners can also help firms to obtain required resources quickly, which is particularly important with regard to tacit resources (i.e., non-observable knowledge and skills), as these are slow to develop internally (Eisenhardt & Schoonhoven, 1996). This quick access to required tacit resources may facilitate and foster the innovation process, which can result in enhanced innovation performance. In addition, outside-in OI can improve innovation processes by providing resources from external partners, which can reduce innovation-related costs and risks (Eisenhardt & Schoonhoven, 1996). This is especially important for firms operating in highly-competitive markets based on cost-driven strategies (Eisenhardt & Schoonhoven, 1996). Moreover, collaborating with external partners to capture their knowledge may enhance the firm’s technological capabilities (i.e., set of tasks and procedures that bring together external and internal knowledge), enabling it to better incorporate the external resources into its innovation processes. By turning external and internal resources more easily into novel configurations, firms can increase the probability of innovation success (Helfat & Peteraf, 2003).

Accordingly, a recent case study on the Lilly Open Innovation Drug Discovery (OIDD) platform describes Lilly as tapping into external knowledge to develop successful innovations. Through the OIDD platform, Lilly has met a great number of scientists who can help its internal research teams develop new and/or improved drugs and biopharmaceuticals; and this has boosted innovation performance (Brunswicker, Bagherzadeh, Lamb, Narsalay, & Jing, 2016). In this line, in a cross-industrial study on Dutch firms, Belderbos et al. (2004) found that by engaging in outside-in OI with external partners (i.e., competitors, suppliers, customers, and universities or research institutions) on R&D projects, firms are likely to boost their innovation performance in terms of percentage of total sales resulting from new products or services. Similarly, Faems et al. (2005) showed that when manufacturing firms conduct outside-in OI with external partners, their innovation performance improves, measured by the total turnover derived from new product development. Likewise, Knudsen (2007) showed that when European manufacturing and service firms engage in outside-in OI alongside private research institutions, universities and suppliers, this increases the percentage of total sales resulting from innovation. Similarly, Faems et al. (2005) found that when manufacturing firms conduct outside-in OI activities with external partners (i.e., competitors, suppliers, customers, research institutions, universities, and consultants), their innovation performances improve, measured by total turnover derived from new product development. Similarly, in an empirical study on Korean firms in the Information and Communications Technology (ICT) sector, Hwang and Lee (2010) showed that by sourcing knowledge externally, firms can improve their innovation performance, measured by the percentage of total sales from new products in the market. Finally, based on a large sample of Spanish manufacturing firms, Santamaría, Nieto, and Barge-Gil (2010) provided empirical evidence of the positive effect of outside-in OI mechanisms, such as alliances, on new product development. Thus, the authors hypothesize that:

H1: Outside-in OI is positively related to innovation performance.

6.2.2 The indirect links between outside-in OI and innovation performance: Knowledge sharing and innovation strategy

6.2.2.1 Outside-in OI and knowledge sharing

Several scholars have defined knowledge sharing as making knowledge accessible to stakeholders, both internal (e.g., employees) and external (e.g., customers, suppliers) (Davenport & Prusak, 1998; Hosein Rezazadeh Mehrizi & Bontis, 2009). When embracing outside-in OI, firms gain access to potentially valuable resources, such as ideas and knowledge of external partners. A firm's recognition capacity (a component of absorptive capacity), conceptualized as the ability to identify these resources and value them, is critical in any innovation process (Wesley M Cohen & Daniel A Levinthal, 1990; Todorova & Durisin, 2007).

Knowledge sharing with external partners provides firms with more information about the external partner's resources, and so enables them to better understand and synthesize external resources (Faems et al., 2008). By better understanding and synthesizing external resources, firms can better assess the fit between the external knowledge and that which they require for innovation (Zobel, 2017). Accordingly, Faems et al. (2008) found that, in a research and development collaboration project, partner firms organized technical meetings to foster knowledge sharing, and so to gain better understanding of each other's technical knowledge. Because of these meetings, both partner firms could better assess and use suitable external knowledge for their innovation activity. In fact, in a study of the partnership between DreamWorks and Hewlett-Packard, Narsalay, Brunswicker, Bagherzadeh, and Roberts (2017) showed that the firms even encouraged the exchange of sensitive technical and business information which helped them assess each other's knowledge and innovation needs since, as a former Director of Open Innovation at HP Labs stated, "without sharing knowledge and open communication between partners, I do not think we could have got a really [valuable knowledge] from collaboration" (p. 3).

Despite the importance of knowledge sharing with external partners, several scholars have acknowledged that sharing knowledge inside firms (i.e., among internal stakeholders) is also crucial to identifying relevant knowledge for innovation (Foss et al., 2011; Zobel, 2017). Sharing knowledge internally gives employees a better understanding of the firm's knowledge and innovation needs. In fact, this better understanding of the firm's knowledge and innovation needs shapes the scope and the direction of the firm's external search, which in turn eases the process of identifying and evaluating external knowledge (Zobel, 2017). For example, in a study on the alliance between Esthetique and L'Oréal, Ness (2009) found that both firms did not only share knowledge with each other, but also internally, by promoting joint product-related meetings and activities after starting the collaboration. Thus, when embracing outside-in OI, knowledge sharing is an internal practice that firms must implement to improve their recognition capacity, which is critical to innovation purposes. In line with this reasoning, the authors postulate that:

H2: Outside-in OI is positively related to knowledge sharing.

6.2.3 Outside-in OI and innovation strategy

Various authors have argued that innovation strategy involves a set of management and coordination activities adopted by firms to organize their innovation processes (Robert G Cooper, Edgett, & Kleinschmidt, 2004; Saleh & Wang, 1993). These activities include the development of innovation roadmaps, a clear perspective on areas that require innovation, a formal planning process, budget allocation, and a review procedure (Adams et al., 2006; Robert G Cooper et al., 2004; Saleh & Wang, 1993). An innovation strategy communicates a clear direction for innovation by specifying focal innovation areas that the firm needs to address (Pisano, 2015; Saleh & Wang, 1993). By determining focal innovation areas, firms can identify the knowledge that they require to complete their innovation processes.

In addition, implementing a formal planning process and review procedure may help firms obtain more information about their innovation activities and performance levels, which is likely to result in a better understanding of their knowledge needs to achieve innovation success (Robert G Cooper et al., 2004; Robertson, Casali, & Jacobson, 2012). Understanding knowledge needs shapes the scope and direction of the firm's external knowledge search, helping it identify valuable knowledge for its focal innovation areas (Todorova & Durisin, 2007). The innovation strategy also helps internal processes to identify external knowledge and to assess how well external knowledge fits the firm's knowledge needs (H. Chesbrough & Crowther, 2006; Chiaroni et al., 2010, 2011). Accordingly, Brunswicker and Vanhaverbeke (2014) found that small and medium-sized enterprises engaging in external knowledge sourcing have an innovation strategy, a formal planning process, and formal innovation project control. Similarly, in a multiple case study of Italian firms, Chiaroni et al. (2010) showed that firms embracing outside-in OI activities develop a formal planning process and a review procedure to evaluate the progress of their innovation projects. Accordingly, the authors posit that:

H3: Outside-in OI is positively related to innovation strategy.

6.2.4 Knowledge sharing and innovation performance

In addition to improving the ability to identify and access external knowledge (i.e., recognition capacity) during outside-in OI activities, Wesley M Cohen and Daniel A Levinthal (1990) suggested that assimilation and exploitation capacities (i.e., the other two components of absorptive capacity) are also important to the firm’s innovation capability and performance. After identifying the relevant external knowledge, firms need to analyze, process and diffuse it internally (i.e., assimilation capacity) (Zahra & George, 2002). Assimilation capacity enables firms to transform external knowledge into forms that they can use internally (Zahra & George, 2002). External knowledge is usually absorbed in a form that employees are unable to interpret and understand (Zobel, 2017). In that sense, knowledge sharing between firms and external partners can help firms to obtain more information about the characteristics of the external knowledge, and thereby make it more understandable for employees (Zahra & George, 2002). Moreover, sharing knowledge between firms and external partners fosters social integration between external partners and the firm’s employees (Browning, Beyer, & Shetler, 1995; Faems et al., 2008). As a result, employees are likely to improve their attitudes, which is crucial for better interpreting and understanding external knowledge (Ghisetti, Marzucchi, & Montresor, 2015; Zahra & George, 2002). Apart from exchanging knowledge with external partners, firms should also share knowledge in-house, to ensure that the absorbed external knowledge is available to the different business units and departments (Foss et al., 2011).

After assimilating the external knowledge, firms need to determine how to apply it and combine it with internal knowledge (i.e., exploitation capacity) (Wesley M Cohen & Daniel A Levinthal, 1990; Zahra & George, 2002). Knowledge sharing between firms and external partners can facilitate the alignment process between external and internal knowledge, as the involved actors understand better the knowledge required for innovation processes (Faems et al., 2008). As a result of this alignment, firms can improve the various combinations of internal and external knowledge (Zobel, 2017). Moreover, retrieving already assimilated external knowledge is crucial for such combinations. Internal knowledge sharing can foster this retrieving process, leading to a more efficient combination of internal and external knowledge. By improving combinations of internal and external knowledge, firms can use it more effectively, and so leverage external knowledge into new contexts and methods of application (Zahra & George, 2002; Zobel, 2017).

Accordingly, in a cross-industrial study, Lin (2007) found that internal knowledge sharing is positively related to innovation performance. Likewise, based on a dataset of 169 Danish large firms from 29 industries, Foss et al. (2011) showed that information exchange between employees across different departments of a firm improves innovation performance, measured by innovation capacity and profitability, relative to competitors. In a similar vein, in a survey-based empirical study involving high-technology firms from China, Wang and Wang (2012) showed that knowledge sharing inside firms has a positive impact on innovation performance. Similarly, in a research and development collaboration project, Faems et al. (2008) found that when the partners share technological information, they improve their innovation performance. Overall, knowledge sharing inside firms and with external partners can pave the way for the assimilation and the exploitation of external knowledge, and thereby foster innovation performance. Thus, the authors hypothesize that:

H4: Knowledge sharing is positively related to innovation performance.

6.2.5 Innovation strategy and innovation performance

An innovation strategy can support the assimilation of external knowledge, because it makes clear the characteristics of the knowledge required for innovation, and thereby helps firms to understand and interpret external knowledge (Zahra & George, 2002). Innovation consists of identifying applications for the assimilated external knowledge and combining external knowledge with internal knowledge (i.e., exploitation capacity) (Zahra & George, 2002; Zobel, 2017). In that sense, an innovation strategy can lead to improved exploitation of external knowledge, because a formal planning and a review process that are part of the innovation strategy help to identify applications for such external knowledge, and also to combine the assimilated external knowledge with internal knowledge (Chiaroni et al., 2011). In this line, Kogut and Zander (1992) argued that the firm's capability to generate new applications using external knowledge leads to improved innovation performance. Thus, firms can take advantage of external knowledge by developing an innovation strategy that supports combinative capabilities.

Accordingly, in the context of SMEs, Brunswicker and Vanhaverbeke (2014) showed that innovation strategy and innovation project control are positively associated with innovation performance, measured by income derived from innovation. Similarly, in the area of highly innovative projects, Salomo, Weise, and Gemünden (2007) found that having a formal process for managing and controlling innovation projects leads to improved innovation performance, from the product, market, and finance perspectives. Therefore, the authors postulate that:

H5: Innovation strategy is positively related to innovation performance.

6.2.6 Knowledge sharing and innovation strategy

As discussed above, knowledge sharing supports the assimilation of knowledge, making external knowledge available to employees in a form that is understandable to them. Active observation and monitoring of the internal innovation process to identify potential applications for the assimilated knowledge, is crucial for the exploitation of such knowledge (Zobel, 2017). To observe and monitor the internal innovation process effectively, firms need to introduce certain formal processes, such as a formal planning and a review procedure (Robert G Cooper et al., 2004; Vlaar, Van den Bosch, & Volberda, 2006). Also, having sufficient information about the focal innovation areas is important for effectively monitoring the internal innovation process (Pisano, 2015). These formalities and focal innovation areas need to be specified and implemented through an innovation strategy (Robert G Cooper et al., 2004; Saleh & Wang, 1993).

Knowledge sharing can facilitate the assimilation of external knowledge (Foss et al., 2011; Zahra & George, 2002). Once the assimilated external knowledge is available across the whole organization, firms need to explore potential applications of it, and determine how to combine it with internal knoweldge (Wesley M Cohen & Daniel A Levinthal, 1990; Zahra & George, 2002). An innovation strategy determines the scope of the observation and monitoring of the innovation process, thereby supporting the identification of potential applications of the assimilated external knowledge (Chiaroni et al., 2010; Todorova & Durisin, 2007). Moreover, an innovation strategy helps employees to effectively match the internal and the assimilated external knowledge (Zobel, 2017), and provides firms with sufficient information about knowledge needs, helping them to filter out unfeasible assimilated external knowledge (H. Chesbrough & Crowther, 2006). Thus, developing an innovation strategy is crucial once firms have assimilated the external knowledge captured through knowledge sharing (Chiaroni et al., 2011; Zobel, 2017). In line with these arguments, we posit that:

H6: Knowledge sharing is positively related to innovation strategy.

6.3 Methodology

6.3.1 Data collection and sample

The data for this study comes from a survey completed mainly by senior executives working in the fields of R&D and innovation (i.e., Chief Innovation Officers, Chief Technology Officers, R&D Directors, and OI Directors) belonging to Exnovate, the European Network of Excellence on Open and Collaborative Innovation (www.exnovate.org), a non-for-profit organization through which OI practitioners can learn about OI and exchange best practices. The Exnovate network contains approximately 7000 OI practitioners, mostly located in Europe and the United States, almost one third of whom work in large companies that actively engage in OI. This makes the sample relevant to this study and minimizes key-informant bias (Kumar, Stern, & Anderson, 1993).

A first email invitation was sent to a subset of 2234 OI practitioners. To increase the response rate, the potential participants were divided into several waves, and reminder emails were sent to non-respondents. In the end, 160 responses were received. Some of these contained missing values on the key variables of this study, which reduced the final sample to 112 companies. To assess late-response bias, various statistical tests (ANOVA test, two-sample t-test, and Chi-square test) were conducted, comparing early and late respondents based on the key variables in this paper and on the variables related to firm characteristics. The results showed that there are no significant differences between early and late respondents in terms of outside-in OI, knowledge sharing, innovation strategy, innovation performance, firm size, OI duration, innovation intensity, and industry groups. These results confirm the absence of late-response bias. Some 53.6% of the respondents work in manufacturing companies. The others work in various service industries, including professional services, wholesale, transportation, public utilities, finance, insurance, real estate, and retail. Agriculture and mining represent 4.5% of the respondents. Finally, most respondents (88.4%) are innovation experts who work in R&D departments; in other departments that engage in OI (i.e., sales, marketing, purchasing, operations, and logistics); or have senior management positions in their company. This indicates that the respondents are suitable for this study. Table 1 depicts the sample distribution across industry groups and job roles.

Table 6.1. Sample distribution across industry groups (based on SIC codes) and respondent job functions

Industry groups	**%**
Agriculture, Forestry, and Fishing	1.8
Mining	2.7
Manufacturing	53.6
Transportation and Public Utilities	2.7
Wholesale Trade	8.9
Retail Trade	4.5
Finance, Insurance, and Real Estate	3.6
Professional Services	22.2

Respondent job functions	**%**
Innovation, R&D, and technology experts	55.3
Management (senior level)	25
Other	19.7

6.3.2 Measures

To operationalize the constructs of knowledge sharing, innovation strategy, and innovation performance, a set of perceptual measures were adopted from the survey developed by Atos Consulting to study the implementation of the OI activities of their company clients (De Man, 2010). This was to our knowledge the most detailed survey that has examined how firms organized OI activities internally, which is the focus of our study. Moreover, this survey included relevant scale items to measure the constructs in our study, and was designed to collect data from C-level managers (i.e., senior executives working in the fields of R&D and innovation, including Chief Innovation Officers, Chief Technology Officers, R&D Directors, and OI Directors), which made it suitable for our study. To refine the adopted measures, the authors conducted a first pretest with 30 MBA students, which enabled to improve the wording and usability of such measures.

To further refine the measures, the authors conducted a pilot study with three OI practitioners.

The knowledge sharing construct captures the extent to which a firm shares knowledge inside the firm itself, and with external partners. Respondents ranked the following three items on a five-point Likert scale, between 1 "Strongly Disagree" and 5 "Strongly Agree": (1) Both internal and external knowledge sharing takes place continuously and is well-supported by knowledge management process; (2) there is systematic knowledge sharing within my company; and (3) in our company there are regular discussions as to whether people are working effectively together.

The innovation strategy construct captures the extent to which a firm manages and coordinates its innovation processes based on an innovation strategy. Respondents ranked the following three items on a five-point Likert scale, between 1 "Strongly Disagree" and 5 "Strongly Agree": (1) My company has a strong innovation strategy relative to competitors; (2) innovation is managed throughout the company (i.e., there is a formal planning process, C-level approval, budget cycle, review procedure, substantial number of people have innovation targets); and (3) my company has a clear view on how it wants to develop its product portfolio (i.e., complete product roadmaps, identified areas to innovate, and necessary resources assigned).

The innovation performance construct measures a firm's innovation success. Respondents ranked the following three items on a five-point Likert scale, between 1 "Strongly Disagree" and 5 "Strongly Agree": (1) In regards to innovation, my company is more successful than three years ago; (2) in regards to innovation, my company is more successful when compared to competitors; (3) I am satisfied with the current performance, in regards to innovation, within my company.

Measuring innovation performance is particularly challenging, because the literature includes different types of innovation performance measures (e.g., Ritala & Hurmelinna-Laukkanen, 2013; Tomlinson, 2010). A number of studies have used patent data (e.g., patent counts) as an objective measure of innovation performance (e.g., Ahuja, 2000; Baum, Calabrese, & Silverman, 2000). However, "given firm-specific variations in the propensity to patent, and given the very real possibility that patents are an input into the product development process and not an output," using patents as a measure of innovation performance has major limitations (Deeds & Hill, 1996, p. 51). Moreover, "most patents are not commercialized and they are widely acknowledged to be a partial indicator of the innovation process only, since many innovations are only partly covered by patent protection, or not patented at all" (Laursen & Salter, 2006, p. 134). The propensity for patenting also differs considerably between industries, and therefore using this measure for innovation performance is problematic with a cross-industrial dataset (Levin, Klevorick, Nelson, & Winter, 1987), which is the case in our paper. Thus, most recent studies of OI, particularly those using survey data, have measured innovation performance using self-reporting subjective measures, asking firms to rate their innovation success (on Likert scales) by comparing current innovation performance with past innovation performance, or with competitors' innovation performance (e.g., Foss et al., 2011; Ritala & Hurmelinna-Laukkanen, 2013; Salge et al., 2013; Schleimer & Faems, 2016; Zobel, 2017). In line with this recent research in OI, we measured the firm's innovation performance by asking respondents to compare their current innovation performance with both their past innovation performance and the innovation performance of their competitors (i.e., three subjective measures of innovation performance). These self-reporting subjective measures of innovation performance are widely used in the literature, because they are relatively straightforward and unambiguous in capturing the conceptual domain of the construct, and they have also proved to be sufficiently reliable (e.g., Foss et al., 2011; Ritala & Hurmelinna-Laukkanen, 2013; Salge et al., 2013; Schleimer & Faems, 2016; Zobel, 2017). In addition, asking for a direct comparison with past innovation performance and competitors' innovation performance makes it possible to measure the superiority of innovation performance explicitly (Danneels, 2008). To check the validity of the subjective measure of innovation performance, we triangulated this measure with a self-reporting objective item of innovation performance based on the percentage of revenue generated by products or services introduced to the market. The objective data were available for a subset of 103 firms. The correlation between these objective data and the average of the three subjective measures of innovation performance was positive and significant (r=0.316, p-value=0.001), indicating the validity of our subjective measure of innovation performance.

Finally, the outside-in OI construct captures the extent to which a firm engages in outside-in OI activities for its internal innovation purposes. Respondents were asked how often each of the following five activities occurred (Henry Chesbrough & S. Brunswicker, 2014): (1) My company uses crowdsourcing (the act of taking a job that is traditionally performed by an employee and outsource it to an undefined, generally large group of people in the form of an open call); (2) we use information intermediaries to find and use external ideas (companies that help innovating companies to use external ideas more rapidly); (3) my company uses alliances to acquire additional knowledge; (4) we use brainstorms and invite our entire network to join; and (5) my company licenses Intellectual Property (IP) from other companies. These items were ranked on a five-point Likert scale: 1 "Never," 2"Rarely," 3 "Sometimes," 4 "Often," and 5 "Always." The survey included a clear explanation of two relatively new OI activities (i.e., crowdsourcing and information intermediaries) to ensure that all respondents interpreted them properly. As the focus of this research is to capture the firm's overall outside-in OI activities, we did not discriminate between different types of outside-in OI activities, and thus created a composite average measure (an arithmetic mean) for all five outside-in OI activities.

To avoid potential confounding effects, and in line with the previous literature, the authors controlled for a set of firm-level characteristics that can influence innovation performance (Brunswicker & Vanhaverbeke, 2014; Faems et al., 2005; Hottenrott & Lopes-Bento, 2016; Laursen & Salter, 2006). The authors controlled for firm size by using the number of employees as a proxy. Larger firms have more resources to invest in outside-in OI, which may affect innovation performance. Thus, respondents indicated the number of internal employees in their company, based on five categories (see Table 6.2), and four dummy variables were included, being the benchmark dummy the last category (i.e., >15000 employees). The authors also added four dummy variables to control for the duration of OI, and created a benchmark for the last category (i.e., >10 years). Respondents answered the question "how long has open innovation been implemented in your organization?" based on five categories, of which the last was defined as the benchmark dummy (see Table 2). The authors also controlled for the intensity of outside-in OI activities over the last three years, measured by "the percentage of new products or services in the last 3 years including externally obtained knowledge." Four dummy variables were added to the model, as respondents were provided with five categories, where the benchmark dummy was the last one (i.e., 81-100%), to indicate outside-in OI intensity (see Table 2). Finally, the authors included 7 dummy variables for 8 different industries in the model, based on Standard Industrial Classification (SIC) codes (i.e., agriculture, forestry, and fishing; mining; manufacturing; transportation and public utilities; wholesale trade; retail trade; finance, insurance, and real estate; and professional services) to control for potential cross-industry differences related to outside-in OI activities and innovation processes.

Table 6.2. Sample characteristics by control variables

Number of employees in 2013	***%***
1-500	20.5
500-1000	3.6
1000-5000	12.5
5000-15000	17.9
>15000	45.5
OI duration as of 2013	***%***
< 1 year	18.8
1 - 3 years	19.6
3- 5 years	19.6
5 - 10 years	20.5
> 10 years	21.5
Outside-in OI intensity over the last 3 years as of 2013	
0-20%	53.6
21-40%	17
41-60%	17
61-80%	5.3
81-100%	7.1

6.4 Data Analysis

6.4.1 Construct analysis

To test the factor structure and convergent and discriminant validities of the constructs, the authors conducted a confirmatory factor analysis (CFA) using the maximum likelihood method in AMOS 22.0. To evaluate goodness of fit, the authors used chi-square ($\chi 2$), goodness of fit index (GFI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). The results showed an acceptable fit for the hypothesized four-factor model (χ^2= 78.865 with *df* = 71 (χ^2/ *df* = 1.11) and p-value = 0.224; GFI = 0.908; CFI = 0.979; RMSEA = 0.032; 90 % CI for RMSEA = (0-0.065); SRMR = 0.059). All the fit indices were acceptable in light of the recommended cut-off values (Hu & Bentler, 1999).

In addition, the four-factor model was significantly better in chi-square than the other more parsimonious models. For example, the authors tested a three-factor solution in which the items of the following constructs were set to load on a single factor: innovation strategy and innovation performance ($\Delta\chi^2$ = 9.714, Δdf = 3, p-value = 0.02); knowledge sharing and innovation performance ($\Delta\chi^2$ = 47.027, Δdf = 3, p-value < 0.001); outside-in OI and innovation performance ($\Delta\chi^2$ = 54.456, Δdf = 3, p-value < 0.001); knowledge sharing and innovation strategy ($\Delta\chi^2$ = 22.396, Δdf = 3, p-value < 0.001); knowledge sharing and outside-in OI ($\Delta\chi^2$ = 11.825, Δdf = 3, p-value = 0.008); and innovation strategy and outside-in OI ($\Delta\chi^2$ = 43.372, Δdf = 3, p-value < 0.001). All these results supported the hypothesized four-factor structure.

Thereafter, the authors analyzed in detail the factor loadings of the items. All standardized factor loadings were significant and greater than the suggested cut-off value of 0.50 (Fornell & Larcker, 1981; Hair et al., 1995) except for the outside-in OI construct (item 1: 0.43 and item 5: 0.36, but both significant and very close to the threshold). To check for discriminant validity, the authors compared the square root of the average variance extracted (AVE) of each construct with the correlation of that construct with all other constructs. The square root of the AVE of each construct was higher than its correlation with all the other constructs, except for innovation performance, where it was the same as the correlation with innovation strategy. These results supported the discriminant validity of the constructs (Fornell & Larcker, 1981).

Finally, we calculated the corrected item-total correlation, composite reliability (CR) values, Cronbach alphas coefficients, and Omega coefficients to assess the reliability of the constructs. All items had the corrected item-total correlation above the cut-off value of 0.25 (between 0.33 and 0.6) (Nunnally & Bernstein, 1994). The Cronbach alpha coefficients ranged from 0.64 to 0.72, the CR values from 0.63 to 0.73, and the Omega coefficients from 0.64 to 0.73. All reliability coefficients were very close to the recommended cut-off value of 0.7 (Fornell & Larcker, 1981; Nunnally & Bernstein, 1994; Peterson, 1994). Moreover, the Cronbach alpha coefficients of all four constructs did not improve if any of their items was removed. Overall, these results indicate adequate reliability for all four constructs in this study. Table 6.3 shows the CR values, Cronbach alpha coefficients, and Omega coefficients.

Table 6.3. Range, means, standard deviations, correlations, squared root of AVE, CR, and Cronbach Alpha

	Min	Max	Mean	SD	1	2	3	4	CR	Cron-bach Alpha
1- Innovation performance	1	5	3.18	0.77	0.64				0.67	0.7
2- Outside-in OI	1.2	4.4	2.89	0.7	0.22*	0.52			0.63	0.64
3- Knowledge shring	1.3	5	3.41	0.83	0.49**	0.49**	0.69		0.73	0.72
4- Innovation strategy	1.3	5	3.65	0.83	0.64**	0.43**	0.54**	0.66	0.65	0.68

* p<0.05, **p<0.001, Squared root of AVE on the diagonal

6.4.2 Common method variance

This study is vulnerable to common method variance (CMV), as data were collected from a single informant in each firm (Podsakoff & Organ, 1986). However, the fact that the dependent and independent variables were proximally separated in the questionnaire reduced the potential CMV issue (Podsakoff et al., 2003). Thus, the respondents were not primed to connect the independent and dependent variables, which limited the chance that their responses to one set of questions would affect their answers to the other questions. Moreover, as most of the measures related to outside-in OI activities and the two mediating variables were quite objective, the probability of overemphasizing the use of outside-in OI activities, innovation strategy, and knowledge sharing was reduced. Therefore, even if the dependent variable is inflated to some extent while the independent variable and the mediators are accurately measured, the results of this study are more likely to have an underestimation bias than an overestimation bias.

Nevertheless, to test the possibility of the results being biased by CMV, the authors first conducted the Harman's single-factor test (Podsakoff et al., 2003;

Podsakoff & Organ, 1986), based on CFA, using the maximum likelihood method, and setting all the items related to the dependent and independent variables to load on a single factor. The results showed that the single-factor model did not provide an acceptable fit with the hypothesized model (χ^2= 146.281 with *df* = 77 and p-value < 0.001; GFI = 0.816; CFI = 0.813; RMSEA = 0.09; SRMR = 0.09). The hypothesized four-factor model provided a significant chi-square improvement over the single-factor model ($\Delta\chi^2$ = 67.416, Δdf = 6, p-value < 0.001). The hypothesized four-factor model also improved other fit indices compared to the single-factor model (ΔGFI = 0.09; ΔCFI = 0.17; ΔRMSEA = 0.06; ΔSRMR = 0.03). Moreover, the subjective measure of innovation performance was positively correlated with a self-report objective item of innovation performance, which gives validity to the subjective measure of innovation performance used in this study. Based on all this evidence, we concluded that the CMV's effect was not large enough to bias the results of the study.

6.4.3 Statistical methods

Table 3 shows the minimum and maximum values, means, standard deviations, and correlations of the constructs. An examination of the correlation between independent variables showed that multicollinearity was not a concern in this study. The authors also calculated the variance inflation factor (VIF) for the four constructs in all regression models. The VIF ranged between 1.33 and 2.44, indicating that multicollinearity was not a significant issue in the regression models. The authors calculated the skewness and kurtosis of all items to check their distribution. The results showed that all items were normally distributed (i.e., skewness ranged from -0.834 to 0.462, and kurtosis from -0.866 to 0.866) (S. G. West et al., 1995). In addition, the results showed that outside-in OI was positively associated with innovation performance ($r=0.22$ and $p<0.05$), and with both mediators - knowledge sharing ($r=0.49$ and $p<0.001$) and innovation strategy ($r=0.43$ and $p<0.001$).

To test the hypothesized model and to understand how outside-in OI affects innovation performance through knowledge sharing and innovation strategy (i.e., mediation analysis), the authors adopted the procedure suggested by Edwards and Lambert (2007); Andrew F Hayes (2013), which has been largely used by scholars to test mediated relationships. Given that the dependent and mediating variables are continuous, the authors conducted a set of ordinary-least-squares (OLS) regression models (Andrew F. Hayes & Rockwood, 2017) to estimate (see Table 4): (1) the effect of outside-in OI on the two mediators of knowledge sharing and innovation strategy (Model I and II); (2) the impact of knowledge sharing on innovation strategy (Model II); (3) the total effect of outside-in OI on innovation performance (Model IV)□ (4) the direct influence of outside-in OI on innovation performance (Model V)□ and (5) the impacts of both mediators on innovation performance (Model V). Thereafter, the authors estimated the indirect effect of outside-in OI on innovation performance through the mediators of knowledge sharing and innovation strategy. To estimate the indirect effect, the authors used the product of regression coefficients from the above-mentioned estimations (1) and (2). To test the significance of the indirect effects, the authors used the bootstrapping procedure (Shrout & Bolger, 2002), which is free of the normally-distributed errors assumption. Specifically, the authors used 5000 bootstrapping samples to calculate bias-corrected confidence intervals for the significance test (Edwards & Lambert, 2007; Andrew F Hayes, 2013; Mooney et al., 1993). Before conducting all these analyses, we calculated an arithmetic mean of the items of each construct to create single indicators for each construct. All analyses were conducted in SPSS 23.0, and the indirect effects were tested using the PROCESS macro 2.16.2 (Andrew F Hayes, 2013).

The assumption of the normally-distributed errors in the OLS regression model was fulfilled, indicating that the OLS estimation is consistent. The authors checked the homoscedasticity assumption of the OLS regression by plotting the residuals against the predicted values of innovation performance (i.e., dependent variable), outside-in OI (i.e., independent variable), innovation strategy and knowledge sharing (i.e., mediating variables). No pattern in the plots was found, indicating that the homoscedasticity assumption was fulfilled.

6.5 Results

Table 6.4 shows that outside-in OI is positively related to both knowledge sharing (Model I: $\beta = 0.498$, $p<0.001$) and innovation strategy (Model II: $\beta = 0.211$, $p=0.021$), supporting hypotheses 2 and 3, respectively. There is also a positive relationship between knowledge sharing and innovation strategy (Model II: $\beta = 0.442$, $p<0.001$), supporting hypothesis 6.

Table 6.4 also shows the total (Model IV) and direct (Model V) effects of outside-in OI on innovation performance. Some of the control variables and industry dummies have a significant effect on innovation performance (Model III). Including outside-in OI (Model IV) added a significant explained variance (3.4% - $\Delta F=4.562$, $p=0.035$). Results indicated that the total effect of outside-in OI on innovation performance is positive and significant ($\beta=0.245$, $p=0.035$). Including the two mediators (i.e., knowledge sharing and innovation strategy) to the model (Model V) added a significant explained variance (30.4% - $\Delta F=35.369$, $p<0.001$).

The direct effect of outside-in OI on innovation performance is no longer significant (Model V: β = -0.073, p = 0.449), and thus the first hypothesis is not empirically supported. However, knowledge sharing is significantly and positively related to innovation performance (Model V: β = 0.226, p=0.019), which supports the fourth hypothesis. The relationship between innovation strategy and innovation performance is also significant and positive (Model V: β = 0.615, p < 0.001), which supports hypothesis 5.

Table 6.4. Multiple regression of hypothesized relationships

	Outcome				
	Mediators		**Innovation Performance**		
Variables	Model I Knowledge sharing	Model II Innovation strategy	Model III	Model IV Total effect	Model V Direct effect
Mediators					
Knowledge sharing		H6: 0.442^{***} (0.09)			H4: 0.226^{**} (0.089)
Innovation strategy					H5: 0.615^{***} (0.095)
Independent variable					
Outside-in OI	H2: 0.498^{***} (0.098)	H3: 0.211^{**} (0.107)		0.245^{**} (0.127)	H1: -0.073 (0.107)
Control variables					
Number of employees					
1-500			-0.006 (0.283)	0.067 (0.285)	0.094 (0.215)
500-1000			-0.033 (0.387)	0.016 (0.391)	-0.015 (0.296)
1000-5000			-0.045 (0.259)	-0.024 (0.255)	0.117 (0.197)
5000-15000			-0.032 (0.216)	0.024 (0.218)	0.034 (0.165)
OI duration					

< 1 year			-0.236* (0.257)	-0.225* (0.252)	0.05 (0.203)
1 - 3 years			-0.301** (0.246)	-0.294** (0.241)	-0.01 (0.193)
3- 5 years			-0.114 (0.236)	-0.097 (0.232)	0.045 (0.179)
5 - 10 years			-0.08 (0.227)	-0.081 (0.222)	0.075 (0.176)
Outside in OI intensity over the last 3 years					
0-20%			0.182 (0.294)	0.282 (0.297)	0.262* (0.224)
21-40%			0.131 (0.322)	0.153 (0.317)	0.153 (0.239)
41-60%			0.034 (0.324)	0.003 (0.319)	0.074 (0.242)
61-80%			0.207* (0.402)	0.201* (0.394)	0.166* (0.298)
Industry dummies (7 dummies)			Yes	Yes	Yes
Intercept	1.706*** (0.292)	1.407*** (0.317)	3.516*** (0.329)	2.512*** (0.607)	0.334 (0.527)
Δ R^2	0.248	0.333	0.279	0.034	0.304
Δ F-statistic	36.199***	27.173***	1.87**	4.562**	35.369***

Note: Standardized coefficients are reported. Standard errors are in parentheses. Bold numbers indicate the standardized coefficient for each hypothesis (H1 – H6).

Two-tailed test: * p<0.1; ** p<0.05; *** p<0.001

The three possible indirect effects of outside-in OI on innovation performance were also estimated. As shown in Table 6.5, all three possible indirect effects are significant. Namely, outside-in OI significantly influences innovation performance via knowledge sharing (Indirect effect #I: β = 0.113; 95% CI = [0.025; 0.247]), via innovation strategy (Indirect effect #III: β = 0.13; 95% CI = [0.033; 0.274]), and following the path through both knowledge sharing and innovation strategy (Indirect effect #II: β = 0.135; 95% CI = [0.069; 0.291]).

Table 6.5. The indirect effects of outside-in OI on innovation performance

Indirect effects	Coefficient (Bootstrap standard errors)	95% CI*
I) Outside-in OI → Knowledge sharing → Innovation performance	0.113 (0.058)	[0.025; 0.247]
II) Outside-in OI → Knowledge sharing → Innovation strategy → Innovation performance	0.135 (0.055)	[0.069; 0.291] +
III) Outside-in OI → Innovation strategy → Innovation performance	0.13 (0.061)	[0.033; 0.274]

Note: Standardized coefficients are reported.

* 5000 bootstrap samples for bias-corrected bootstrap confidence intervals

+ Bias-corrected bootstrap confidence intervals at 99%: (0.047; 0.346). This shows that this indirect effect is also significant at 99% confidence level.

Overall, the results show that the relationship between outside-in OI and innovation performance is indirect. Knowledge sharing and innovation strategy fully mediate the impact of outside-in OI on innovation performance. This indicates that firms can only turn outside-in OI into improved innovation performance through innovation strategy and knowledge sharing.

6.5.1 Robustness analyses

As the homoscedasticity assumption of the OLS was fulfilled, we also checked the robustness of the significance tests by using heteroscedasticity-consistent standard error (HC3 estimator) (Long & Ervin, 2000). The results did not differ from those found without using the HC3 estimator.

As this paper focuses on the linear relationship between outside-in OI and innovation performance, we needed to ensure that there is no curvilinear association between these variables. To do so, we added the square values of outside-in OI to the model. The model fit remained the same ($\Delta R2=0.014$, F change=1.842, $p=0.178$) and a non-significant coefficient for the squared term was found, supporting the linearity of the association between outside-in OI and innovation performance. we also found support for the linearity of relationships between outside-in OI and the two mediators, and between the two mediators and innovation performance.

As this article also studies the mediating effects of knowledge sharing and innovation strategy in the relationship between outside-in OI and innovation performance, we tested their potential moderating effects by adding two interaction terms to the model. To avoid a multicollinearity issue that could emerge from adding the squared and interaction terms, we centred the values of outside-in OI, knowledge sharing, and innovation strategy on their means before multiplying (Jaccard et al., 1990). The model fit remained unchanged for the knowledge sharing interaction term ($\Delta R2=0$, F change=0.011, $p=0.915$) and for the innovation strategy interaction term ($\Delta R2=0.001$, F change=0.044, $p=0.835$). No significant moderating effects were found, supporting the mediating effects of knowledge sharing and innovation strategy.

Another concern in this study is the potential endogeneity of outside-in OI and innovation intensity, which can inflate the relationship between outside-in OI and innovation performance. Innovation intensity can influence the level of engagement in outside-in OI activities, and simultaneously affect innovation performance. To control for this potential endogeneity issue, we included a proxy for innovation intensity in the model using the percentage of revenue spent on innovation. To control for the fixed effects of innovation intensity, we included four dummy variables. Respondents indicated "what percentage of your revenue is spend on innovation in the last year?" based on five categories (1: 0-5%, 2: 6-10%, 3: 11-15%, 4: 16-20%, and 5: more than 20%), the last of which was considered as the benchmark category. After adding this variable, the sample size decreased to 99 firms due to missing values. We found the same results for all hypotheses and no significant changes regarding the direct (β=0.001, p=0.993) and indirect effects (#I: β=0.107, significant at 90%; #II: β=0.153 and #III: β=0.157, significant at 95% confidence level), supporting the robustness of the results.

As previous studies argue, firms that use patents in their innovation processes are likely to boost their innovation performance, regardless of whether or not they engage in outside-in OI (Deeds & Hill, 1996; Pakes, 1985). Moreover, case-based evidence suggests that firms only use a fraction of their patents in innovation processes, and that this fraction differs between firms (West et al, 2006). Therefore, we controlled for the effect of patent usage heterogeneity on innovation performance to ensure that our results are not confounded by this effect. To do so, we included four dummy variables in the model. Respondents indicated "what percentage of your patents are you actually using to create new products or services during the last 3 years?" based on five categories (1: 0-5%, 2: 6-10%, 3: 11-15%, 4: 16-20%, and 5: more than 20%), the last of which was considered as the benchmark category. This measure captures the percentage of the firm's patents used in the innovation process. However, this measure does not capture the number of patents developed by the firm during the innovation process. Due to some missing values for this variable, the sample for this analysis was 92 firms. All hypotheses were supported except H1 (β=0.037, p=0.772), which is consistent with the findings we present in the Results section, and supports the robustness of our results. We found no substantial changes in the indirect effects (#I: β=0.094, significant at 90%; #II: β=0.136 and #III: β=0.162, significant at 95% confidence level) of outside-in OI on innovation performance, which shows that our results are not confounded by the use of patents in the innovation process.

6.6 Discussion and Conclusion

6.6.1 Theoretical implications

OI is increasingly popular in innovating firms, which assume that simultaneously tapping into internal and external knowledge sources leads to stronger innovation performance. Despite this assumption, empirical studies have shown that engaging in outside-in OI leads to mixed results. Some studies provided empirical evidence confirming that outside-in OI boosts innovation performance (Cheng & Huizingh, 2014; Du et al., 2014; Faems et al., 2008; Laursen & Salter, 2006; Salge et al., 2013), and others have found that outside-in OI has no effect or even damages innovation performance (Caloghirou et al., 2003; Campbell & Cooper, 1999; JH Dyer et al., 2006; Knudsen, 2007; Knudsen & Mortensen, 2011; Lhuillery & Pfister, 2009; Un et al., 2010). This mixed empirical evidence may be explained in different ways. One reason could be the adoption of different firms' internal practices for managing innovation processes. In line with previous studies, the authors assume that companies require a particular type of internal organization to tap successfully into external knowledge (e.g.,Foss et al. (2011)). Outside-in OI requires a set of appropriate internal practices to reach out and collaborate effectively with external partners, and thus to assimilate and integrate their knowledge into internal innovation processes (Brunswicker & Vanhaverbeke, 2014; Chiaroni et al., 2011; Foss et al., 2011; Salter et al., 2014).

To unpack the link between outside-in OI and innovation performance, the authors set up a model to test whether internal practices help OI-adopting firms improve their innovation performance. As presented in Figure 1, the authors tested whether outside-in OI has a direct effect on innovation performance, or if the relationship is mediated by certain internal practices for managing innovation processes. More precisely, the authors focused on the management of innovation processes through knowledge sharing and innovation strategy as critical practices for leveraging the knowledge of external partners. These practices were introduced as mediators of the relationship between outside-in OI and innovation performance. The empirical analysis shows that if the internal practices of knowledge sharing and innovation strategy are introduced as mediators of the relationship between outside-in OI and innovation performance, outside-in OI impacts innovation performance indirectly rather than directly, as the relationship is fully mediated by both knowledge sharing and innovation strategy.

The empirical findings of this research highlight the importance of the internal practices of knowledge sharing and innovation strategy for successful outside-in OI activities, and have a set of academic implications. In the past, OI scholars have focused on the benefits of working with external partners (Cheng & Huizingh, 2014; Faems et al., 2005; Laursen & Salter, 2006). A lot of attention has concentrated on how and why firms should connect to partners (Faems et al., 2008; Salge et al., 2013). This focus has developed historically, although Chesbrough's seminal work on OI (H. Chesbrough, 2003c; H. Chesbrough, Vanhaverbeke, & West, 2006b) pays considerable attention to the internal management of outside-in OI activities. The results of this study indicate that an exclusive focus on the relationship with external partners is unsuitable to estimate correctly the impact of outside-in OI on innovation performance. Internal practices that help firms perform outside-in OI activities have to be taken into account, explaining how they can have a positive impact on innovation performance. Since both knowledge sharing and innovation strategy fully mediate the impact of outside-in OI on innovation performance, it can be concluded that if studies ignore the internal organization of OI when measuring the impact of outside-in OI on innovation performance, their results may be considerably biased. This finding addresses the call by J. West and Bogers (2014a) to conduct further research on the relationship between outside-in OI and performance. It suggests that it is essential to incorporate internal practices when analyzing the impact of OI activities on firms' innovation success, and thereby clarifies why some outside-in OI activities are successful and others are not.

So far, only a few papers from the field of OI have studied the role of internal practices in outside-in OI activities (Brunswicker & Vanhaverbeke, 2014; Foss et al., 2011; Lakemond et al., 2016). By unpacking the relationship between outside-in OI and innovation performance, this study adds to the literature by introducing two internal practices as critical factors for making outside-in OI activities successful. In addition, the results of this research further build on the indirect effect of embracing outside-in OI with customers on innovation performance found by Foss et al. (2011), by considering a wider range of external partners in the analysis. Finally, the results of this study complement the research conducted by Lakemond et al. (2016) who considered outside-in OI and internal practices as independent variables to predict innovation performance, but did not analyze how outside-in OI and internal practices may be related in determining innovation performance.

6.6.2 Managerial Implications

The findings of this research also have interesting managerial implications. If the internal practices of knowledge sharing and innovation strategy are important to guarantee successful outside-in OI, managers cannot just start working with OI overnight. Success is only guaranteed when a firm is internally prepared and organized for OI. Thus, this study has two major takeaways for managers: (1) An exclusive focus on establishing innovation-oriented relationships with external partners (i.e., embracing outside-in OI) is not sufficient to boost innovation performance; and (2) managers that intend to use outside-in OI should prepare the company internally by developing an innovation strategy and internal and external knowledge sharing processes, if they want to boost innovation performance. This is not a new idea: it has appeared in several studies focusing on OI maturity. In fact, capabilities related to the internal organization of OI (e.g., knowledge sharing and innovation strategy) can be considered as dynamic capabilities (David J Teece, 2007). These capabilities have to be developed over time, leading to the idea of OI maturity. Enkel et al. (2011b) developed a 5-level OI maturity framework to measure the effectiveness of OI in firms. It is based on three major internal capabilities: climate for innovation, partnership capability, and internal process.

The empirical results of this paper show that the internal organization of OI is the forgotten dimension in the field of OI. Despite Chesbrough’s seminal work

(H. Chesbrough, 2003c; H. Chesbrough et al., 2006b), case-based evidence (Chiaroni et al., 2010, 2011; Salter et al., 2014) and the development of practical management tools, such as the OI maturity framework, both scholars and managers have almost exclusively focused on how to reach out to partners without considering the need to adapt internally to the new OI requirements. The new imperative is to take a balanced approach to OI development, focusing simultaneously on how to reach out to partners and how to change the firm internally.

6.7 Limitations and Future Research

This study has some limitations. First, further research should validate the findings. It is difficult to find a large sample of OI-adopting companies. External validation of the findings is crucial and it will require large sample surveys. Second, the authors limited their attention to two internal practices and did not include other practices, such as those related to corporate culture. It is only possible to understand the full impact of internal organization on OI effectiveness if all practices are considered. Third, we did not differentiate between outside-in OI activities in our model. In any type of outside-in OI (e.g., R&D alliance, crowdsourcing, OI intermediaries, in-licensing), it is crucial to have a clear innovation strategy if firms want to improve innovation performance (e.g., Zobel, 2017). However, some types of outside-in OI (e.g., R&D alliances) require more extensive knowledge sharing between the focal firm and external partners than others (e.g., OI intermediaries and in-licensing agreements), where knowledge exchange with external partners is very limited or even inexistent (e.g., Cammarano et al., 2017; Felin & Zenger, 2014; Santamaria et al., 2010). Therefore, it is reasonable to expect that each specific outside-in OI activity will affect the level of knowledge sharing with external partners differently. Thus, future research should provide a detailed analysis of the interaction between external knowledge sharing (i.e., knowledge sharing between the focal firm and external partners) and each specific outside-in OI activity to refine our study. For this detailed analysis, future research could use project-level datasets to investigate the specific outside-in OI mechanism applied, and the extent of knowledge sharing with external partners, in each specific innovation project.

Fourth, although our measures of innovation performance are widely used in the literature and they have also proved to be sufficiently reliable, future studies could further validate our measure of innovation performance by using objective secondary data on new product or service market introduction announcements (i.e., number of new products or services introduced to the market) (e.g., Katila & Ahuja, 2002; Luger, Raisch, & Schimmer, 2018; Zobel, 2017). These data can be collected from secondary sources, such as editorially controlled new product announcements, technical and trade magazines, and product catalogues or press releases related to new products or services. (e.g., Katila & Ahuja, 2002; Luger et al., 2018).

Fifth, as this study is based on cross-sectional data, causal relationships between outside-in OI, knowledge sharing, innovation strategy and innovation performance are difficult to establish. Therefore, future research should develop longitudinal and/or experimental designs to confirm the causality between these constructs. Nevertheless, it can be difficult to obtain longitudinal data from senior managers or involve them in experiments, due to their busy schedules. Moreover, company policy can prevent senior managers from taking part in research, particularly experimental studies, due to confidentiality concerns. As developing longitudinal or experimental studies with managers can be problematic, future research could conduct computational experiments or simulations (Burton & Obel, 2011) to test the causality between the constructs in this study and to check the reciprocal relationships between them over time. Despite the fact that the cross-sectional data used in this study capture the effect of outside-in OI on two mediators and innovation performance, causal relationships are difficult to establish. Therefore, future research should develop longitudinal and/or experimental designs in order to confirm the causality between the variables present in the hypothesized model. Finally, the concept of OI maturity (and dynamic capabilities) indicates that OI management is a long-term process requiring continuous improvement to internal practices. The analysis conducted in this paper is static, but a dynamic analysis would be highly welcome, to explain how the development of different internal practices leads to more effective OI over time, and how different strategies to develop internal practices lead to more effective OI activities.

Chapter 6 References

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Chapter 7. Discussion and Conclusion

Table of Contents for Chapter 7

The overarching theme of this thesis is open innovation readiness; that is, how a company can organize itself internally to use open innovation effectively. Since its introduction, open innovation has become increasingly popular. Prior literature has examined how companies can prepare themselves to either begin using or better manage open innovation activities. This is an important topic for researchers and a crucial aspect in developing successful open innovation for practitioners. Research on open innovation readiness addresses the same broad topics as open innovation studies as a whole. One thesis cannot successful address all aspects of a broad topic like open innovation readiness; therefore, I chose to focus this study on particular aspects within the topic's wider scope.

The subthemes that were chosen as the focus of the research in this thesis are open innovation metrics, the career profiles of open innovation practitioners, and the effects of various open innovation practices on a company's openness and innovation performance (which is further broken down into three sub-subthemes). Appropriate research methods, including literature review, study of LinkedIn profiles, and analysis of the results of a survey on open innovation, were designed to address these subthemes. While these subthemes do not exhaustively cover the subject of open innovation readiness, they provide insight into how a practitioner can think about starting open innovation practices or improving their effectiveness.

As each subtheme is written as a stand-alone chapter in this thesis, this discussion and conclusion chapter will first address each subtheme as addressed within its corresponding chapter. Where discussions and conclusions cut across several chapters (particularly in the three chapters that address the survey), then those sections will be merged. As they also vary across subthemes, limitations and future research discussions will be broken up by chapters as well. The end of this chapter draws connections and conclusions across the subthemes to show how they relate to the broader topic of open innovation readiness.

7.1 Careers of Open Innovation Practitioners

The chapter on the career profiles of open innovation managers was born out of both necessity and convenience. In the professional and business literature, the management of open innovation is a widely discussed topic, with each article emphasizing a particular aspect of open innovation management. Many of these articles interview open innovation practitioners and report the lessons they have learned about specific open innovation practices. However, these practitioners themselves, and especially their career progression are rarely the subject of study. As open innovation is essentially a people business and primarily relies on the relationships between people and their partnerships, this lack of information is not healthy. Conveniently, there is a huge database of self-reported information on the career progression of open innovation practitioners in LinkedIn, a public website service essentially listing a professional's CV.

This chapter is meant to address the lack of empirical evidence on the profiles of these practitioners/managers. Basic questions, such as how long they remain in an open innovation job, how long is their tenure in a company, what is their age, what did they do before, and what job they assumed afterwards, were addressed by extracting and analyzing this data from LinkedIn.

When I focus on the background of these managers, I find that on average, they are relatively senior, having a long tenure at their employer. From this, I conclude that the role of the open innovation manager cannot be an entry-level position. Successful managers must understand the routines and structure of the company, have built both internal and external networks, and have the seniority to be listened to and respected.

Furthermore, someone who becomes an open innovation manager tends to stay in this position for a long time on average. This role is not a temporary job from the perspective of either employee or employer. Open innovation managers need to be fully committed to the open innovation initiatives within a company. Since they stay for a long time, they provide the needed stability and continuation for these open innovation practices.

Without empirical evidence, it has been assumed that the majority of these open innovation managers came from R&D, as open innovation is traditionally associated with the research and development department within a company. However, the evidence from LinkedIn shows that only 40% come from R&D, while the rest come from various departments with, for instance, commercial or legal functions. This shows that managing open innovation needs different competencies, not only from R&D functions. This is not really surprising as open innovation is all about developing and commercializing new products or services, where not only technological, but also market and customer knowledge is vital.

I also investigated what open innovation managers do after they leave their open innovation positions. Most stay at the same company and go back to their previous department. This is an important indication that they take the open innovation philosophy with them and disseminate the open innovation culture to their department, leading to long-term, decentralized adoption of open innovation culture. Those who do leave that company may start their own company, but many go to another company, usually a non-competing company.

Ultimately, this research allows me to view how several high functioning open innovation companies manage the human aspect of their open innovation activities. It provides a snapshot of an 'average' open innovation manager- the ones effectively driving open innovation in large companies. A better understanding of the profile of these managers allows companies to benchmark their OI teams to the newly discovered average profile. These benchmarks allow companies to see how their OI managers compare to those of other companies. This research may allow companies to realize that short term open innovation assignments are not very useful, as the average successful OI managers are long term employees who have built up credibility in an organization, and who are unlikely to leave to start or join competing companies. The results of this study may also encourage companies to draw open innovation management talent from a broader range of departments rather than focusing only on those in R&D. As a normative statement about these OI managers, assuming that their long tenure within a company as an OI manager is due to their success in that position, the ideal OI manager would be one with seniority and tenure, both in the company itself and in the OI role. It might be better if he or she came from R&D, but that is not a determining factor.

The data that I used for this chapter comes exclusively from LinkedIn, which means that it is self-reported. I searched only for senior open innovation managers who worked in companies known to be working with open innovation at a high level. This data gives me information in a very indirect way about how these companies manage the human aspect of their open innovation activities.

For future research, alternative research methodologies such as interviews, extensive surveys, or case based research will need to be applied to fully understand and explain the profile, background, career progressions of these open innovation managers.

Another approach would be to focus on the bosses and internal clients of these open innovation managers. Current research has only looked at open innovation teams themselves and perhaps some open innovation partners, but not the other stakeholders of these open innovation teams. It would be helpful to triangulate the perspectives of the senior managers (the bosses of these open innovation managers) and their customers (such as business unit managers) to better understand the careers of these managers. To date, no research has yet been done on this topic.

This chapter provides management with several implications for how to manage human resources. It shows companies who practice open innovation what kind of background, work history and profile is ideal for open innovation practitioner, including where they come from and what career trajectory they might follow. The chapter also provides some clues about how to compose open innovation teams and what skills are required in such teams. It further provides evidence that only a minority of OI managers leave the company after their OI job and only a small percentage of these people go to competitors. There is not much information about this topic in prior literature and a further investigation of this topic is necessary to get a full understanding of our preliminary findings. This topic has to be studied in greater detail linking for instance OI managers' personality or profile to the OI-job requirements.

7.2 Measurements of Open Innovation

This chapter provides a framework for open innovation metrics, and uses this framework to discuss the availability and appropriateness of open innovation metrics. Metrics are used by those who manage open innovation to report and to aid in decision making, in order to drive positive change in an organization. The importance of appropriate metrics cannot be understated. In organizations, these metrics provide an objective indication of how open innovation is progressing. Metrics that are not appropriate to open innovation practices may measure the wrong things, or fail to provide guidance specific to the requirements of open innovation, thus leading managers to make decisions that do not maximize their open innovation strategies.

The development and usage of metrics for open innovation has been limited in the past. Practitioners and researchers initially adopted metrics that had been developed for closed innovation. Those closed innovation metrics are often not applicable to open innovation settings as open innovation's ways-of-working and ways-of-thinking are so different. Thinking about open innovation metrics as simply slightly modified closed innovation metrics is unworkable.

One of the contributions of this chapter is to provide a structure for open innovation metrics, a framework with which to categorize open innovation metrics. Designing a conclusive, exhaustive framework is difficult for an evolving practice like open innovation, but building this framework makes apparent the gaps where measurements still need to be developed, or where existing measurements might be modified to fit.

To this end, this chapter looks at metrics developed for closed innovation companies and examines which can be used, with or without modification, for companies engaged in open innovation practices. It shows that it is often difficult to adapt these metrics to a different context. As open innovation uses both external and internal sources of innovation, there is no longer a linear relationship between the internal input measures (such as R&D expenditures or number of R&D employees) and innovation output (number of patents; number of inventions; share of sales from new products, etc.). Thus, the chapter proposes new types of metrics which are more suitable for open innovation, especially the ones measuring the nature and results of interactions with partners. These new metrics are developed from the ground up, using the framework developed in the chapter to identify gaps and then building metrics which would be appropriate to meet the identified need. These new open innovation metrics take into account the ways in which open innovation is distinct from closed innovation.

As an implication for managers, I caution that measuring and monitoring open innovation is not an easy task due to issues at several levels. Managers will need to create or employ new metrics, convince senior management of their usefulness, and then gather data, including from partners who many not have the same capability to gather and report on this information. Despite its difficulty, this chapter suggests that managers need to use open innovation metrics as an important reporting and management tool.

There are several limitations to this chapter. First, it is not exhaustive in reporting on existing open innovation metrics. It gathers open innovation metrics from both professional and academics journals, but other metrics may be used by companies but are not publicly disclosed or reported in the literature. Such metrics would not be included in this chapter, though they should fit in the framework it suggests. Because metrics for innovation, especially for open innovation, are not well discussed in the literature, there were few resources to draw from and this chapter relied on a relatively small list of existing papers.

While this chapter created a structure to categorize open innovation metrics, commented on which metrics from closed innovation could be used for open innovation, and proposed new open innovation metrics, its proposals have not been fully validated by industry. As this chapter is intended for use by open innovation practitioners, further research would need to be done to validate its findings and suggestions, perhaps using interviews or a survey among open innovation practitioners. Going further, case studies in how a company develops and uses open innovation metrics would provide deeper insight into the practicalities of this topic.

One of the main audiences for whom this thesis is written are the open innovation managers, the professionals who are responsible for the management of open innovation activities in their companies. In this chapter I draw two major conclusions relevant to this audience. First, in an open innovation era, traditional measurements are not always useful or may lose meaning. Managers need to be very careful in using classical closed innovation metrics. In fact, due to their ongoing use and widespread acceptance, these classical metrics may be imposed on open innovation practitioners. For example, the R&D intensity metric (R&D expenditures divided by sales) is a widely known and used classical metric, but since it does not measure the R&D expenditures from partners, it is useless as an open innovation metric. However, I suspect that open innovation managers will face an uphill battle for an if they try to abandon such a well-known metric.

Second, managers need to be able to use new metrics, as there are many gaps in the existing metrics and there is certainly a need to create new ones. Managers face two problems in trying to do this: First, how do you get them (perhaps with shared information and measurements with partners)? Second, how to do you standardize these new metrics across the company, or even industry? In both instances, the proper collection and benchmarking of data remain hurdles to using new metrics. However, if both problems can be addressed, developing and using these new metrics would be immensely beneficial.

7.3 Descriptives of Survey

The last three chapters of the thesis are based on a survey that was filled out by senior open innovation executives, mostly working at large companies. We received 160 responses with differing levels of usefulness depending on the analysis being performed. The driving motivation behind the creation of the survey was to explore if there is a link between the elements of a company's innovation strategy, how its open innovation, inside-out and outside-in activities are internally organized, and its innovation performance. Ultimately, we wanted to examine the linkages between the open innovation activities, the internal organization and the readiness for open innovation.

In chapter 4, I focus on the descriptives of the survey and simple "eyeball" statistics. It is interesting to note that majority of survey respondents (59%) have increased their use of open innovation in the last three years. This is in line with the findings of H. Chesbrough and Brunswicker (2013); Henry Chesbrough and S. Brunswicker (2014)). I also analyzed the reasons respondents gave for engaging in open innovation: the top responses are about exploring new capabilities, finding new business opportunities, finding new technology, and shortening time to market.

I also did an exercise on grouping different questions about internal readiness (internal organization and strategy) and open innovation modes (inside-out and outside-in). Using a statistical technique known as primary component analysis (PCA), which groups questions together based on the similarity of the responses, I could see which questions were related, and the characteristics they share, known as factors. With a reduced number of factors, I could have a clear overview of the internal dimensions of a company and the open innovation practices. For example, for outside-in practices there is a clear distinction between licensing-in from other organizations, sourcing external ideas and collaboration with partners. Using PCA on inside-out practices, I find that there are two factors: an effective process to monetized unused technology and knowledge, and an active search for external routes to market.

The academic literature identified dozens of types of these open innovation modes, but their categorization is problematic. Henry Chesbrough and S. Brunswicker (2014) have categorized these modes, based on a mixture of conceptual work and case studies. The advantage of using PCA is that it uses the insights and perspectives of the open innovation practitioners (the respondents) to better understand how they differentiate between different types of open innovation modes both for outside-in and inside-out open innovation. Reducing the complexity of open innovation brings clarity into how open innovation managers conceptualize open innovation and allows me to connect innovation performance to open innovation activities and readiness in relatively simple terms.

Very little literature on the internal organization of open innovation has made explicit the optimal organizational structure and strategy for facilitating open innovation. I developed part of the survey to answer the question: "What is a good strategy for internal OI organization?" The survey asks respondents to rate a number of items on a 1 to 5 scale. The items are exploratory, taken from prior literature, our own insights from case studies and interviews with open innovation practitioners. Again, using PCA gave me insight into the major dimensions of strategy that can facilitate open innovation activities. The four factors that came up are having a clear (open) innovation strategy, knowledge sharing, use it or lose it strategy, and use of legal protection. Each of these factors can be related back to prior literature (H. Chesbrough et al. (2006a); Dodgson, Gann, and Salter (2006); Hagedoorn and Zobel (2015); Veer and Lorenz (2014).

I also explored the organizational structure and processes that facilitate open innovation. I found four factors: support for open innovation in the company, development of open innovation skills, empowerment of employees, and the creation of an open innovation mindset in the company. The first factor, support for open innovation in the company, refers to the level of management and organizational support for open innovation; the second factor is comprised of items regarding the company's ability and commitment to developing open innovation skills and competencies; the third factor refers to the freedom and empowerment of employees to take entrepreneurial actions in the company; and the fourth factor is about the employees' open innovation mindset (such as having internal and external knowledge sharing). In the past, researchers relied on case studies to investigate this topic. In contrast, this study is one of the first times a large number of open innovation practitioners were questioned about how open innovation is structured in their companies, with Henry Chesbrough and S. Brunswicker (2014) a notable exception.

These four factors are important to advance open innovation research, as little attention has been paid in the professional and academic literature to how companies can facilitate open innovation by developing appropriate structures and processes. One of the main points of interest in the survey was whether these four factors have any impact on innovation performance. Do these factors really matter? Are they relevant or important? To answer these questions, I did a simple test. I split the sample of respondents in two groups – those that performed above and below the median. I then compared the two groups against three indicators for success (internal success over 3 years, respondent versus competitors, and innovation performance). The first two factors (robust innovation strategy and knowledge sharing) are important in affecting innovation performance. The other two factors did not show the same results.

Using the same technique for organizational structure, I find some evidence that open innovation support in the company and open innovation mindset positively influence satisfaction with current innovation performance. In contrast, open innovation skills development has positive influences on making a company's innovation management more successful than competitors.

Additionally, do these two internal variables (strategy and internal organization) have any impact on outside-in and inside-out? I also found that the four strategy factors (robust innovation strategy, knowledge sharing, use it or lose it, and IP protection) positively affect both outside-in and inside-out. For internal organization, the factors open innovation skills development and employee empowerment positively affect both, with mindset having an effect only on outside-in, and open innovation support having no effect on either. This shows that there is a clear association (but not necessarily a causal association) between level of readiness and open innovation.

Open innovation maturity, which is related to experience in using open innovation, was also measured in this survey. The findings suggest that a company's success is greater when it is more mature in using open innovation. This suggests that in many companies, open innovation initiatives may not be successful at the beginning. Reaching success in open innovation is a long-term process that needs investment, time, and experience.

7.4 Limitations of Survey and Descriptives Chapter

After much effort, I was able to obtain 160 survey respondents, who provided responses with varying degrees of usefulness. A limitation of this paper is its small sample size. However, it is roughly the same as other studies of its kind (H. Chesbrough & Brunswicker, 2013), demonstrating the difficulty in getting a substantially larger response.

This survey is one of the first attempts to come up with the right terms and items to describe and compartmentalize the different aspects of general strategy and innovation strategy facilitating open innovation. To develop the questions in the survey related to the innovation strategy, I could rely only on a few published papers. Therefore, I relied also on a number of interviews. The same applies to the aspects of organizational structure and processes; in this case I had some more literature to work with (Lindegaard, 2010), but there was still no extensive literature that explored which concepts are important and valuable.

I used PCA to group various questions and responses together into factors for a deeper analysis. Most of the factors can be easily interpreted and can be recognized in the literature. This is an indication that the survey results corroborate the insights generated by case study research (Chiaroni et al., 2010; 2011). However, as this is the first time that open innovation readiness has been explored in a larger sample of open innovation managers, more empirical evidence is needed to strengthen the internal and external validity of the different factors I found. Future research might also look at the aspects that I didn't explore, such as communication strategy or the HR aspects of open innovation.

This chapter on the descriptive of the survey results only scratches the surface. It gives a first impression of what can be found in the survey. However, this chapter is packaged as a management report that can be read independently from the rest of the thesis: it is my intention to send it out as a report to the respondents and later on to many other (open) innovation managers to provide them some easy way to absorb insights on how companies are organizing themselves to facilitate open innovation. The other two chapters based on this survey each go deeper into a specific research topic by focusing on one specific item, and keeping other items constant.

7.5 Firm Openness and Innovation Performance: Two In-Depth Analyses of the Survey Results

Chapter 5 looks at factors explaining the degree of openness in a firm. It tests whether three factors (which we call organizational antecedents)- entrepreneurial orientation in a firm, a company's support of open innovation, and the open innovation skills development - have an impact on firms' level of openness. Some literature shows that entrepreneurial orientation leads to openness (Rauch, Wiklund, Lumpkin, & Frese, 2009), but other authors have argued that employee freedom and flexibility/autonomy do not automatically lead to more open innovation (Salter et al., 2014). We do not find a direct effect in our study. Entrepreneurial orientation is essentially about managers empowering their employees to take entrepreneurial action, but this is not sufficient to facilitate open innovation. We find that entrepreneurial orientation has a positive effect on open innovation support and open innovation training. Open innovation support does not have an impact on openness but does facilitate open innovation training. The latter in turn has a strong positive effect on openness. In other words, the effect of entrepreneurial orientation is fully mediated through open innovation training. These findings show that it is easy to come to the wrong conclusions about the effect of entrepreneurial orientation if other variables are omitted. Providing freedom and flexibility to employees will only lead to more open innovation activities if there is open innovation training (preferably combined with open innovation support from top management and different functional departments).

Chapter 6 (the third chapter devoted to the survey) focuses on the factors affecting firms' innovation performance. As in the previous chapter, we analyze outside-in open innovation activities, innovation strategy and knowledge sharing and their impact on innovation performance. These factors were taken from the analysis done in the descriptives chapter, and analysis shows that they do indeed have an impact. In literature, we find that outside-in open innovation has a direct impact on innovation performance (Faems et al., 2005; Salge et al., 2013; Zobel, 2017). Our hypothesis is that innovation strategy and knowledge sharing may mediate this direct impact. In this chapter, we show that these two factors have a positive effect, and that firms only benefit from outside-in when innovation strategy and knowledge sharing are in place.

In other words, many publications have shown that open innovation has a positive effect on innovation performance. However, these studies do not have the rich data about the internal organization of open innovation generated by the survey. Once internal factors, such as innovation strategy and knowledge sharing, are introduced in the regressions, they tend to fully mediate the direct effect of open innovation activities on innovation performance. The results of the last chapter indicate that the previous literature is wrong in assuming that establishing open innovation activities will (automatically) lead to higher innovation performance. Firms need to have their innovation strategy and knowledge sharing practices in place in order for open innovation activities to have their desired impact on innovation performance. This outcome is not so surprising, as many firms are not successful with open innovation because they did not change internally to adapt for and facilitate open innovation.

7.6 Limitations and Future Research on These Two Chapters from the Survey

The survey focused on external innovation modes, strategy and organizational variables, and success factors of open innovation. We find that a company's internal structure and processes, along with its strategy, help increase the level of open innovation and to improve innovation performance.

A number of potentially relevant areas were not addressed by this analysis. For instance, the level of inside-out open innovation may be influenced by internal factors and by the fact that the firm is active in outside-in open innovation. Put more succinctly: is there a reason to believe that if you are accustomed to working in outside-in open innovation you would be able to be successful in inside-out innovation? If a company is active as an outside-in open innovator, it has routines and processes which already involve working with external partners, and therefore it may only take a small step to start inside-out activities, and vice versa. I suggest that these activities may be positively linked, but more empirical studies are needed to validate this claim.

In the chapter on firm openness (Chapter 5), we did not consider taking innovation strategy into account as a factor in the analysis. It is plausible to assume that innovation strategy might lead to more openness or substitute for internal organization factors; however, further study is required to validate such a claim.

While a few survey questions addressed open innovation maturity, I did not analyze these responses in depth. Further research could use maturity as an additional variable in an analysis. This might show that the deployment of open innovation activities and the internal organization of open innovation probably co-evolve over time, as firms move from low to high stages of open innovation maturity.

7.7 Limitations

The database that was generated from the survey responses is bounded by several limitations. I would like to further address the internal validity of concepts such as strategy and internal organization. Additionally, external validity needs to be further explored. The sample of 160 respondents will eventually not represent the population of open innovation practicing companies, especially as this sample size may be smaller for certain analyses. It would be interesting to see if these results are the same for other companies, industries, and geographic areas.

While data on the perspective of open innovation professionals and their career progression is important from a human resources perspective, it is difficult to translate this information directly into management practice. To enhance usefulness for open innovation practitioners, we should also look at topics such as IP, top management related issues, and communications. With the survey, we could only look at two dimensions of open innovation (innovation strategy and internal organization), which is of course a strongly limiting perspective in terms of relevance for management. Therefore, it is recommended to include other internal variables in future analyses.

Another way to validate our findings would be to speak to managers and see what they think of the results. Doing so would especially enrich the chapters that resulted from the survey, by adding the thoughts and comments of managers into the text. Additionally, for the metrics chapter, I could work with open innovation practitioners to see if the metrics are usable and practical for their needs. Later, I could try to use these metrics to generate hard numbers and verify their practical use. This objective data would then be used to further measure and analyze open innovation similar to the work of Du et al. (2014). Ultimately, I would like to find the right metrics for open innovation, which could be adopted and put into widespread use.

I have deliberately chosen very specific research questions to answer, especially in chapters 5 and 6. However, we did lose sight on the overall topic of readiness. I did not cover linking OI readiness to OI itself or OI readiness to strategy/organizational structure. Indeed, this topic needs to pull many things together, but there was not sufficient time to work on it, as a lot of the focus was on chapters 5 and 6. I had to cut the full analysis for this thesis. Other future avenues of study would be on linking strategy with inside-out and outside-in; the interconnectedness of the four major themes in the survey: strategy, organizational structure, outside-in, and inside-out; or analyzing OI maturity and its link to the four major themes

7.8 Managerial Implications

Chapter 5 shows that just having an entrepreneurial orientation will not create a more open firm, despite what may be reported elsewhere. Because the survey was able to measure open innovation readiness with finer granularity than existing studies, we could demonstrate that there are other factors help make a firm more open. Support of open innovation (from senior management, HR, legal, etc) and open innovation training (training or having a dedicated open innovation team) must work in conjunction with entrepreneurial orientation in order to positively influence openness. While the survey database is cross-sectional and it is not possible to infer causality, there is clearly a positive relationship between these internal variables and firms' inclination to be open.

Chapter 6 shows that using outside-in does not have a direct impact on innovation performance. There must be an innovation strategy and knowledge sharing systems in place in order for outside-in open innovation to have an impact on innovation performance.

Chapters 5 and 6 both show that there is a need for more fine-grained data about open innovation that measure innovation success alongside descriptions of several open innovation activities and the strategy and internal organization of the firm. Developing such a holistic approach for open innovation is important to advance our understanding of open innovation. From chapter 5, I find that enabling employees to practice entrepreneurship (i.e., freedom to take initiative) is not enough to generate higher levels of open innovation. Very specific support is needed for the open innovation team, including company-wide support of their activities and training to develop their open innovation knowledge. Just having support or an entrepreneurial orientation alone is not sufficient. In order for open innovation to be successful, the open innovation team needs freedom and the flexibility but also internal support especially from senior management, legal and HR.

While many papers have proposed a direct link between open innovation and innovation performance, I find that this direct link is illusory. As described in detail in chapter 6, our survey's granularity allows us to argue that this link is mediated by internal factors. Open innovation only works when a firm is internally ready, that is when it has an innovation strategy and knowledge sharing processes in place. Working on open innovation activities alone without organizing a strategy and internal organizational structure is not advisable.

As these two chapters show, internal development takes time to change. After all, firms have to change their culture and mindset from closed to open innovation. However, the more involved a company is in open innovation, the more mature it becomes, and ultimately the better it gets at open innovation. There is no shortcut to open innovation development- both internal organizational development and the external partner development must be done. Essentially, if a company wants to implement open innovation, it must be prepared to invest in it for several years.

7.9 Final Thoughts

The main objective of this thesis is to explore a subset of the numerous aspects of open innovation readiness. With a few exceptions, the chapters which explored these aspects are intended to be more practical, as opposed to more academic, with the open innovation practitioner in mind. Each chapter, while separate and distinct from the other chapters, serves the concept of open innovation readiness, which is to prepare an organization to be more receptive to and more successful with its open innovation practices.

Companies making the transition from closed innovation, where innovation is performed internally, to open innovation, where innovation is a joint effort with external partners, have a journey ahead of them. As open innovation is very much a people driven process, more specifically, a process that demands strong working relationships with external parties, the organization that is not fully prepared to allow for these types of relationships to develop will not be successful in its OI endeavors. An important part of this journey from closed to open innovation is for the company to prepare itself internally to become an open innovation company. This preparation involves coordination and changes in virtually all of the company's internal departments and divisions. However, this preparation to be an open innovation organization, or open innovation readiness, is not widely discussed in either academic or professional literature. The academic or professional literature on this tangential to this subject is mainly focusing on how companies can reach out to potential partners and how to work with partners, and virtually nothing on OI readiness.

What does open innovation readiness look like? What is an ideal strategy or are best practices to become OI ready? These questions are naturally raised when discussing this topic. As this is such an unexplored topic, the truth of the matter is that, we don't know what open innovation readiness looks like. A few writers on open innovation, such as Lindegaard, have lightly approached this. In this thesis, I have attempted a structured approach to answer these questions, effectively a way to understand how the selected internal requirements of open innovation would look like.

These selected internal components reviewed in this thesis are people, metrics, strategy, organization, and maturity. Each of these components align with the MOOI framework for open innovation as mentioned in the introduction chapter. I have explored several important, yet seldom empirically studied aspects. Each chapter emphasizes a certain aspect of open innovation readiness, such as what an ideal open innovation manager's profile looks like, what the culture, processes and inner workings of an ideal open innovation company should be, and what metrics should be used to measure open innovation. Each of these aspects corresponds to an important juncture in the open innovation readiness journey, which is why they were highlighted for further study and I also chose these important aspects of this framework because they lacked rigorous empirical study.

For the people component, I analyzed the open innovation managers of companies who are practicing open innovation. It was discovered that these managers typically have seniority in terms of tenure in the company and in terms of working experience. This demonstrates the need for well-networked, respected, and established professionals who can provide guidance, stability, and the inter-personal connections needed for open innovation.

The analysis of open innovation metrics has shown that there are very few established metrics for benchmarking open innovation. As the ways of working from closed innovation to open innovation are so different, especially since open innovation, by definition requires the collaborative efforts of external partners, most metrics and benchmarks used in closed innovation are not portable to open innovation. Due to this, new ways of measuring need to created. Additionally, a framework of metrics was created in this thesis, in order to inform the thinking of a company looking to create or analyze their own metrics in totality. However difficult it is to create and implement metrics, it is clear that metrics are an important part of the open innovation process, as a way to gauge success in OI efforts and a concise reporting tool to senior managers.

The strategy component was explored primarily in the survey that was created for this thesis. In essence, the research has shown that strategy is an important component in implementing open innovation. However, not all strategic components are created equal for successful implementation. The analysis has shown that only certain strategic choices are effective for open innovation, and a company should be mindful of which choices will lead to a successful OI outcome. Additionally, this thesis has shown that an innovation strategy along with knowledge sharing, both internal to a company, will be needed to have a successful OI deployment.

The internal organization of a company, another component extensively explored in the survey, is especially important in OI readiness. The survey has shown that internal support of a company is one of the most important factors in successful OI implementation, followed by OI skills development. The need for internal support for OI activities and the need for OI skills development should be supported by the company's internal organization. Additionally, when internal OI support and OI skills development is combined with an internal culture of freedom and flexibility, the company becomes more open to external parties, an important aspect of open innovation.

Open innovation maturity is a concept which summarizes how advanced an organization has progressed on its OI journey. Very mature open innovation companies have made deep changes in their ways of working, both internally and externally. My research has shown that companies high in OI maturity are more successful than less mature companies.

When taken in its entirety, this thesis shows that open innovation readiness, which is the internal preparation a company has for open innovation, needs to be well established in order to be successful. It can be deduced that companies who do not have these readiness changes in place will be less successful in their OI efforts. The components explored in this thesis, while certainly not exploring all of the OI readiness components, show that they need to be used in aggregate, as a fully OI ready company use many of these components in conjunction with each other for a maximum benefit.

As these components which are needed to be OI ready are many and some require significant changes in ways-of-working, culture and processes, the journey is long and is not fast nor easy to implement. As similarly reflected in the measurements on maturity, the most mature OI companies are the most successful, but becoming mature takes time and concerted effort. As additionally shown with the OI managers, who are important to become OI ready, a long tenure and presumably a deep network make for successful OI professionals, can only be developed by having a company committed to open innovation.

As these chapters have shown, it is not easy nor fast for a company to get ready for successful open innovation. New metrics must be created; partners must be brought on board; managers must be hired and allowed to develop; and an internal cultural change must take place. However, there are examples out there of successful readiness and implementation, upon which this thesis tries to draw. I hope that this thesis captures at least a portion of what is needed to be ready for open innovation.

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