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FACULTY OF BUSINESS ECONOMICS
Master of Management

Master's thesis

Diversity in open innovation practices - towards a framework of classification

Promotor :
Prof. dr. Anna ROIJAKKERS

Supervisor :
Prof. dr. Wim VANHAVERBEKE

Hamzeh Obeid

Thesis presented in fulfillment of the requirements for the degree of Master of Management

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Summary

Open innovation has been gaining popularity in both academia and industry. Considering the latter, several studies have pointed out the various ways in which firms understand and apply a strategy of open innovation. On the one hand, some understand and use it simply as a means of communication with their customers; establishing platforms whereby feedback from their end users can be garnered and used to improve on existing products and services. In terms of strategy, these firms apply open innovation on a business or even on an operational level. On the other hand, open innovation is also being utilized to pursue long-term and strategic corporate processes such as industrial diversification and corporate renewal. We believe that this discrepancy in open innovation applications, although testament to the richness and popularity of the concept, is nonetheless contributing to an existing confusion about the nature of the innovation paradigm and the goals companies can hope to reap from its adoption, especially considering the current scarcity of scientific means of classifying its practices. Existing scholarly work has shed some light on this problem and advocated the introduction of frameworks of classification as a necessary undertaking to the conceptual development of the open innovation paradigm (Huizingh, 2010).

In this vein, I aim to explore one possible dimension for classifying open innovation practices. Namely, I will use data from four case studies of companies with open innovation programs to investigate the types of partners they involve in their activities. The case studies were based mainly on semi-structured interviews that I personally conducted with the managers responsible for open innovation at these companies. In addition, documentation on the companies' open innovation activities from different sources was studied whenever available in order to increase the credibility and future testability of my results. How did the companies in question go about selecting their open innovation partners? Moreover, is there a relationship between partner types and certain open innovation activities? By focusing on the type of partner, I want to explore the process of partner selection in open innovation and the feasibility of applying this as a means of identification and classification of the various facets of open innovation as well as to explore their different personalities, utilities, and characteristics.

To use a scientific dimension of differentiation between partner types, I adopted the concept of the value net of companies, which was introduced by Nalebuff and Brandenburger in their

book Coopetition in 1996. The value net of a firm includes a firm's suppliers, customers, competitors, and complementors. The authors of the value net framework highlight the unique role each one of these players play in a firm's ecosystem as well as the benefits that can be gained by collaborating with them. They also suggest symmetry among value net actors such as one between suppliers and customers, whereby learning about and working with their suppliers is as important to a firm as learning about their customers. This value net concept, as introduced by Nalebuff and Brandenburger, employs the principles of game theory to describe how a collaboration between the firm and its value net players, including that with competitors, can be to the common good of all the players involved since it can increase the total value that they can then split amongst themselves. Their model, therefore, approached the topic from the standpoint of business strategy, focusing on the issue of value creation and missing any connection to innovation. In fact, we found no mention of collaborative innovation in their book on the topic. Nevertheless, empirical evidence has established a positive relationship between customer involvement in innovation and innovation performance in firms. The same positive effect is also evident when it comes to innovating with suppliers, as well as with the remaining two actors: competitors and complementors. Following this logic, we ventured to investigate the feasibility and potential benefits of employing the concept of the value net as a theoretical foundation to our differentiation between open innovation practices based on the types of partners involved in these endeavors. To do this we aim to investigate how this link holds up in practice by studying the cases of four firms with established projects of open innovation. Were the partners in these projects mainly value net actors or did they involve ones that are more distant? Is there a prevalence of a certain type of player when these companies sought open innovation partnerships? And is this possible prevalence of a certain type of open innovation partner a result of intentional and conscious decisions by firms or is it simply a consequence of other, more significant criteria for partner selection? Our qualitative research methodology particularly suits the objectives we seek since it allows for pattern recognition as well as for the particularization of what is believed to be an existing overgeneralization of phenomena in academic literature.

Our analysis of the investigated cases revealed a lack of systematic processes for partner selection in open innovation. None of the four companies, which, varied in size, open innovation strategy and management, sought actors for its innovation activities according to predetermined criteria. Instead, our results indicate a contingent process of partner selection

that is subject to change on a case-by-case basis. Alas, our results indicate that certain partner types are more relevant when pursuing certain open innovation strategies, leading us to identify strategy and the degree of innovativeness sought as mediating factors which we found the prevalence of certain partner types dependent on. Nevertheless, our study leads us to regard the current haphazard approach to partner selection as one that denies firms consistency in the characteristics and outcomes of their open innovation endeavors.

Table of Contents

List of Figures

List of Tables

Chapter 1 - Introduction and problem statement

Huizingh (2010) states: “Open innovation comes in many forms and tastes, which adds to the richness of the concept but hinders theory development.” Since its introduction in 2003 by Henry Chesbrough the term open innovation has been used to label numerous and miscellaneous company activities. Affirming this view, Vanhaverbeke (2013), argues that open innovation has branded a multitude of heterogeneous phenomena in both academia and industry. Although this growing experimentation with one form or another of open innovation can be considered a healthy sign of its popularity in industry and of interest in the concept, it can also foster confusion on what is or is not open innovation. Dahlander and Gann (2010) observe that despite the growing literature on openness, there is a lack of clarity and some dissatisfaction with how the concept has been used. As an antidote, the introduction of frameworks that distinguish the various forms of open innovation, Huizingh (2010) suggests, is a necessary undertaking to tackle this disparity while facilitating the conceptual development of the innovation paradigm.

My thesis can be considered as a step in this direction. That is to say, it is an attempt to explore patterns among open innovation activities, which may then be used as dimensions of differentiation between those activities. Needless to say, my work is not the first in this regard. A widely cited study by Gassmann and Enkel (2004) identified three core processes of open innovation based on empirical evidence from 124 companies. Depending on the direction of knowledge flow, the processes they identified were outside-in (or inbound), inside-out (or outbound), and a coupled process combining the earlier two. Moreover, aforementioned research by Huizingh has resulted in the development of another framework of classification of open innovation practices whereby he distinguished between the innovation process and outcome, and where each can be open or closed. A closed process of innovation combined with a closed outcome, for instance, is classified as closed innovation according to his framework. In a similar vein, Lichtenthaler (2011) classifies the knowledge management mechanisms employed by firms when pursuing strategies of knowledge exploration, exploitation, or retention, and which he couples with the organizational, project, and individuals’ levels in an organization. And while the research background section of this thesis will more thoroughly review these frameworks and their shortcomings in our opinion, it is sufficient here to argue that they do not offer a comprehensive remedy to the challenge at hand. Thus we believe the exploration of more patterns in open innovation and possible dimensions of differentiation remain essential tasks.

In constructing a framework of classification my approach borrows from business networks the concept of the value net which was introduced by Nalebuff and Brandenburger (1996) in their book titled Coopetition. The value net includes all the players that can affect the value of a firm's offering. These players are the firm's suppliers, customers, competitors, and complementors. Even though the authors of this concept emphasized the benefits a firm can gain from understanding the business of the players in its value net, suggesting curious symmetries among value net actors such as one between suppliers and customers, they stopped short of establishing any connection between their concept and that of collaborative innovation. Researchers of open innovation, however, have not shied away from exploring the type of actors companies are seeking for one form of open innovation or another. A recent study by Smirnova and Podmetina (2013) based on empirical evidence from firms in the Russian market found suppliers, customers, intermediaries, and competitors to be the type of actors with whom open innovation is mostly pursued. Similarly, a quantitative study of 144 companies by Gassmann and Enkel (2008) identifies clients, suppliers, competitors, and public and commercial research institutions as the most cited external sources of knowledge in inbound open innovation. Curiously enough, the companies surveyed described another significant source of inbound innovation knowledge as "non-customers, non-suppliers, and partners from other industries". While the aforementioned studies have shown the significance of some value net partners in open innovation, they stop short of exploring the characteristics particular to innovating with each of these different players. Hence, is open innovation with a supplier different in some aspects from open innovation with a customer? Moreover, what value can distant actors from other industries add in open innovation?

My aim is to investigate a possible link between the value net concept and that of open innovation by exploring how open innovation is pursued within the value nets of the investigated companies then compare that to situations when actors from outside this value net are the ones involved. I aim to provide evidence of characteristic and distinguishing features of open innovation when pursued within a firm's value net and of open innovation when pursued outside this value net. Thus, what are the characteristics, risks, and complexities associated with open innovation activities when pursued with each type of partner in the value net of a firm? And how do these compare to open innovation when conducted with more distant actors?

My approach does address a gap in the existing literature, which has left the process of partner selection in open innovation unexplored, and avoids the limitations of the current

frameworks of classification. Therefore, using qualitative research based on in-depth case studies of four companies I aim to find an answer to the following central research question:

Should open innovation practices be classified along the lines of the value net?

The paper is structured as follows. The second chapter will review the existing literature relevant to the case. Chapter 3 will describe the methodology I followed to design my empirical investigation. Chapter 4 offers a detailed description of the case studies, whereupon in chapter 5 I conclude with findings, managerial implications, limitations of the study, and lastly my recommendations for future research.

Chapter 2 - Research background

2.1 Open innovation

In the book he published in 2003, Henry Chesbrough defined open innovation as:

> "A paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. Open Innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model."

Open innovation, as a paradigm for innovation, is meant to contrast with closed innovation, where a firm seeks to do everything by itself (Herzog, 2010), from idea generation and research to downstream operations all the way to the customer. Firms pursuing a closed innovation model believe that "successful innovation requires control" (Chesbrough, 2003). For firms aspiring to innovate, the closed innovation model instills certain convictions into the mentality of the firm, creating belief that in order to succeed it should hire the best and smartest people, that profiting from innovative efforts requires it to discover, develop, and market everything itself, also that being first to market requires that research discoveries originate within its own boundaries, that leading the industry in R&D investments results in coming up with the best and most ideas and eventually in winning the competition, and that restrictive IP management must prevent other firms from profiting from the firm's ideas and technologies (Chesbrough, 2003). In his book, Chesbrough challenges these principles by proposing a new innovation paradigm which takes into account the following: That the firm must find and tap into the knowledge and expertise of sources outside its boundaries since it is not possible to contain all the innovative knowledge within the firm, that external R&D, when integrated with internal R&D activities of the firm, can create significant value, that being first to the market is not a requirement for winning, that the winning firm is the one that makes the best use of internal as well as external ideas, and that a more lenient IP strategy can allow the firm to profit from the use of its IP by others as well as its own use of others' IP to advance its own business model (Chesbrough, 2003).

It was argued in literature that the principles onto which Chesbrough based his open innovation paradigm in 2003 were exaggerated (Trott and Hartmann, 2009). These authors criticized Chesbrough's dichotomy between what he called closed innovation on one hand and his new open innovation framework on the other. They further accused Chesbrough of

creating a fallacy about closed innovation systems in order to refute and demolish it. Hence they disputed the novelty of the new innovation framework and argued that for the past few decades and long before the introduction of open innovation "substantial efforts have been undertaken to improve the ability of firms to acquire external knowledge." (Trott & Hartmann, 2009) Yet and in Chesbrough's defense, he could have portrayed an extreme 'one end of the spectrum' example of a closed innovation framework to make clearer the disadvantages of such model (Lichtenthaler, 2011). Moreover, and despite their criticism, Trott and Hartmann (2009) acknowledge the popularity of the new innovation paradigm and that even though the trend of openness had already started before its introduction, open innovation can encourage firms to 'jump on the bandwagon' and be more eager to turn into genuinely open innovators. In fact, empirical evidence from industry already suggests a recent increase in open innovation activities (Lichtenthaler, 2011), which can be evidence to that effect.

In 2006, Chesbrough refined his earlier definition of open innovation, describing it as: "The use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough, Vanhaverbeke, & West, 2006). This definition mentions two processes in open innovation; the first is an outside-in process where ideas and research projects can enter the firm's innovation funnel in order to accelerate internal innovation. And the second, referred to as the outflows of knowledge, is an inside-out process where research projects can leave the firm to be used externally. Firms can pursue the first process through knowledge exploration activities, where the firm pursues knowledge acquisition beyond its boundaries. The second process can be pursued through knowledge exploitation activities, where the firm seeks to commercialize its knowledge externally (Lichtenthaler, 2011). In practice, firms employ either one of the processes or both processes together in what some researchers call a 'coupled process' (Gassmann & Enkel, 2004). Based on empirical research, it seems that most firms currently pursuing open innovation focus on the inbound (outside-in) process (Chesbrough & Crowther, 2006). This focus is also reflected in academic research on open innovation (Lichtenthaler, 2011). Although some researchers hint that this prevalence of either process could be industry-dependent. For example, in the chemical industry the inside-out process in the form of licensing is a usual practice (Gassmann & Enkel, 2004) while firms in other industries such as fast moving consumer goods and pharmaceuticals tend to focus exclusively on inbound open innovation activities (Mortara & Minshall, 2011; Lichtenthaler et al., 2011). In general, firms may refrain from the inside-out process due to the perceived risk of strengthening competitors (Lichtenthaler et al., 2011), or giving away a profitable idea where a firm does not want to be the one who "let a big idea go" (Golightly, 2012). Moreover,

the outbound process typically requires the firm to set up dedicated roles for the purpose of managing the activities associated with the inside-out process, such as IP managers (Mortara & Minshall, 2011).

Open innovation activities do not only vary in terms of the direction of knowledge flow. Indeed, adopting a lens of business strategy also shows significant heterogeneity in its practices. For in addition to the mainstream view of open innovation as a catalyst in business-level processes such as achieving better competitive positions in current businesses, Vanhaverbeke (2013) describes how DSM, the Dutch multinational life sciences and material sciences company, utilizes open innovation to achieve its corporate-level strategic objectives. According to his study, DSM develops new businesses or divisions completely new to the firm by utilizing open innovation in its corporate Innovation Center. This application of open innovation, as being a driver of corporate-level processes such as new business development and industrial diversification is not only an example of the role open innovation can play beyond the business-level process of new product development, but it also reveals where the current open innovation frameworks underestimate the applicability of open innovation, leaving a gap in literature which I will review in the following section.

2.2 Existing frameworks of classification

My goal in reviewing existing frameworks of classification in open innovation is two fold: first, I aim to reveal the gap these frameworks leave in open innovation research, and second, to explore the different components used to construct each of the frameworks. These components, such as the dimensions the researchers used for the classification of various phenomena in the context of open innovation, can be useful in our effort to build a framework addressing this gap.

2.2.1 Dahlander and Gann (2010)

Dahlander and Gann set out to develop an analytical framework classifying the different forms of open innovation as discussed in 150 published papers on the topic. Motivating the authors is what they perceived as a conceptual ambiguity of open innovation in literature (Dahlander and Gann, 2010), citing examples whereby research would focus on one or two forms of openness and not the others, resulting in the absence of a comprehensive perspective on the various forms of open innovation. Moreover, the authors attribute the confusion on why some firms profit from their open innovation initiatives more than others to this same effect, namely to the absence of a framework of classification.

Based on their analysis of existing research, the authors identified four themes of openness. These are acquiring sourcing, selling, and revealing. They reached this result by starting with distinguishing the papers focusing on inbound open innovation from the ones focusing on outbound open innovation. This first dimension of analysis was based on a study by Gassmann and Enkel (2004) who identified three core processes of open innovation after studying 124 companies with such initiatives. The processes they identified were outside-in (or inbound), inside-out (or outbound), and a coupled process linking the first two. The framework's second dimension has to do with the means with which the company is pursuing its open innovation activities, being pecuniary (financial) or otherwise (non-pecuniary).

	Inbound open innovation	**Outbound open innovation**
Pecuniary	Acquiring	Selling
Non-pecuniary	Sourcing	Revealing

Table 1. Source: Dahlander and Gann (2010)

2.2.2 Huizingh (2011)

Huizingh also identifies the necessity of developing open innovation frameworks. This, he attributes to the richness of the research on open innovation and which made it difficult to build a coherent body of knowledge (Huizingh, 2011). Here he cites the previously reviewed work of Dahlander and Gann (2010) in order to highlight the heterogeneity of open innovation research. Huizingh dimensions his framework by distinguishing the process and outcome of innovation, where either can be open or closed. The author incorporates in his framework innovation management research from the IT field, where, considering open source software, both the innovation process, and innovation outcome are open. Huizingh also incorporates in his framework the case when both the innovation process and outcome are closed, which reflects Henry Chesbrough's classic definition of closed innovation (Chesbrough, 2003). The resulting framework is shown below.

	Innovation Outcome	
Innovation Process	**Closed**	**Open**
Closed	Closed innovation	Public innovation
Open	Private open innovation	Open source innovation

Table 2. Source: Huizingh (2011)

2.2.3 Lichtenthaler (2011)

Building on the premise that "innovation is inherently a multi-level phenomenon" which was established by Gupta, Tesluk, and Taylor (2007), Lichtenthaler extends this idea to open innovation, arguing, "the adoption of open innovation processes can be determined by drivers at multiple levels." (Lichtenthaler, 2011). What Lichtenthaler aims to categorize, therefore, is not open innovation practices but instead the knowledge management mechanisms that can be employed by companies when pursuing innovation either internally or externally. The first dimension they utilize is the direction of knowledge flow that can be outside-in (knowledge exploration), inside-out (knowledge exploitation), or a combined process (knowledge retention). Secondly, and building on the approach that innovation is a multi-level process, they identify the three organizational levels that are responsible for innovation as a second dimension, namely, these are the organizational, project, and the individual level.

With this framework, Lichtenthaler identifies the micro foundations of open innovation capabilities at the individual level. He also establishes the necessity of developing certain organizational capabilities in order for the firm to successfully manage open innovation. To our study we take from Lichtenthaler framework its utilization of knowledge management processes as a suitable basis for differentiating open innovation processes.

		Knowledge exploration	**Knowledge retention**	**Knowledge exploitation**
Internal	Organizational level	Inventive capacity	Transformative capacity	Innovative capacity
	Project level	Make decision	Integrate capacity	Keep decision
	Individual level	Non-invented-here syndrome	Non-connected-here syndrome	Not-sold-here syndrome
External	Organizational level	Absorptive capacity	Connective capacity	Desorptive capacity
	Project level	Buy decision	Relate decision	Sell decision
	Individual level	Buy-in decision	Relate-out decision	Sell-out attitude

Table 3. Source: Lichtenthaler (2011)

2.2.4 Shortcomings of existing frameworks

Academic literature on open innovation lacks a framework which, based on certain dimensions, can be used to classify different open innovation initiatives all while keeping into perspective how strategy drives these initiatives and is in turn affected by them. To illustrate this we compare the frameworks of classification reviewed earlier.

The framework of Dahlander and Gann (2010) was constructed by reviewing existing research on open innovation and not on an empirical investigation of how companies apply it in practice. Therefore it can be of interest to academics studying the topic but we find it less relevant in industry as it still lacks an insight into the decision process leading to the categories in the framework. There is also no discussion of the type of partners companies should seek to implement a certain activity or another. While Huizingh's stated aim is to classify open innovation practices, he includes closed innovation as a category in his framework. Moreover, we include forms of innovation that are beyond the scope of this study such as open source innovation where the innovation process and outcome are open, and public innovation where the process is closed and outcome is open. Our interest lies within the third category in his framework, which he calls “Private open innovation”, and where the process of innovation is open but the outcome is closed. We believe that this single category in itself encompasses a wide range of open innovation activities and which we set to classify. Therefore we find Huizingh’s framework of classification too general. Lastly, Lichtenthaler’s framework classifies the management mechanisms necessary to facilitate knowledge flow bidirectionally and on multiple levels in an organization. The framework is valuable in industry as it helps managers identify and employ the drivers needed for open innovation. It also presents a comprehensive review of these mechanisms, which in turn reduces ambiguity in the academic field of open innovation. Nevertheless, Lichtenthaler uses a knowledge-management-lens for classification and one that does not fit our purpose of classifying practices of open innovation.

2.3 The value net

This section of the study is concerned with reviewing the literature on open innovation activities pursued with actors within the value net of an organization. Nalebuff and Brandenburger conceptualized the value net of firms, as will be used in this study, in their popular book on Coopetition (1996). Their value net, shown below, depicts the four types of

players in the business of an enterprise, being suppliers, customers, competitors, and complementors.

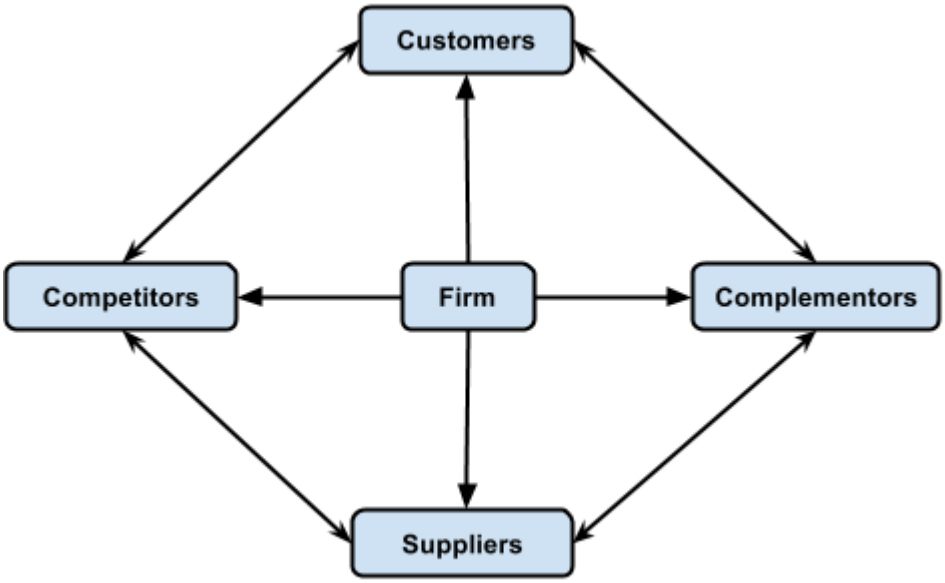

Figure 1. The value net of a firm
Source: Nalebuff and Brandenburger (1996)

The above model of the value net indicates symmetry of actors along the horizontal axis between competitors and complementors and one along the vertical axis between customers and suppliers. This symmetry, according to the authors of the value net, emphasizes the equal importance of establishing relationships between the firm and the different types of actors in its value net (Nalebuff and Brandenburger, 1996). We can categorize the types of actors in this model into 1. Backward actors: these are parties whose output serves as inputs to the firm's business. These can be either market or technology suppliers. An example of the earlier is that of industrial suppliers, while universities are an example of a technology supplier. 2. Forward actors: parties who are concerned with the firm's outputs, such as downstream partners in sales, marketing, distribution, and the customer. And 3. Horizontal actors: parties whose business is either competitive or complementary to the firm's.

The aim of this section is to portray, based on existing literature, the specific and potentially distinct features of open innovation associated with its pursuit with the different types of actors in this net. In other words, is the application of open innovation between firms and suppliers, for instance, different from its application between firms and customers? To

answer this question and to expand on how, if actually proven to be unique, are these types of collaboration different, the research done on open innovation engagements with suppliers, customers, competitors, and complementors will be reviewed. An attempt will also be made to identify any common features among these different cases of open innovation within the value net in order to establish a potential contrast to open innovation when pursued outside the value net of firms. Following this introduction are four sections for each type of partner. In discussing each case, a general framework was followed whenever the existing literature permitted. Firstly definitions of open innovation with the particular type of actor in question are presented. Secondly, the benefits associated with the collaboration with this actor are reviewed, providing an idea of the possible motives for firms to engage them in open innovation. Thirdly, descriptions of the process of engagement are reviewed, including some practical aspects such as the prevalence of particular open innovation activities, being inbound, outbound, or a combination of the two. Also the tools or channels utilized to facilitate the relationship, stages in the innovation funnel where this type of engagement is typically conducted, and the goals typically expected of these open innovation efforts, being explorative, exploitative, or more generic in nature. Fourthly the potential complexities involved in dealing with this particular type of actor are discussed, highlighting issues such as the risks research associates with this mode of open innovation, and as a result the necessity of contractual agreements, knowledge appropriability measures, and organizational changes. Another aspect of complexity discussed is the duration of agreement, and whether it can extend to other stages in the value chain.

2.4 Open innovation within the value net

2.4.1 Suppliers

Suppliers are backward actors whose offering serves as inputs to the firm's business. These can be market suppliers, who provide the firm with raw materials and manufactured components, or technology suppliers whose offering consists of research, patents, and personnel. The following two sections will review the literature on market and technology suppliers separately. Our differentiation between supplier types follows similar efforts in existing literature. One such example is a study in the context of open innovation by Du et al. (2014) in which the authors draw a distinction between market-based partnerships, which include suppliers and customers, and science-based partnerships, which include universities. The study finds characteristics unique to each of these two types of partnerships. For instance, the

authors find that better financial outcomes are associated with a formal management process in the case of market-based partnerships. All while the latter type, referring to partnerships with universities, leads to better results when loosely managed. I will use their findings to justify my distinction between market (industry) suppliers and what I will refer to as technology suppliers, and which will include universities and research institutions.

2.4.1.1 Market suppliers

The crucial role suppliers can play in various stages of the new product development process has received considerable attention in literature, especially in the context of the automobile or aircraft manufacturing industries. This is unsurprising since the trend to integrate suppliers in new product development seems to have begun when American auto manufacturers were exploring how their Japanese counterparts, by then steadily gaining ground in the US market, were going about doing business. The Japanese, as it turned out, had a multi-tiered structure of suppliers where those in the first tier, closest to the auto company, were deeply integrated in the NPD process. Suppliers in this tier seemed like partners to the auto companies rather than simple component manufacturers. In fact, an empirical study by Kamath and Liker (1994) found that suppliers in this tier participate from the pre-concept stage onwards, and have their own technological capabilities, which enables them to collaborate with their customer firms on determining the specifications of new components.

Research has since studied various issues related to supplier involvement, including the stages of development where supplier input is possible, and which can depend on the characteristics of the product (Handfield et al., 1999). In addition, supplier-specific characteristics can play an important role in determining their effectiveness in collaborative innovation, including their technical capabilities, whether or not the supplier has a strategic emphasis on product innovation, the position of the supplier in the supply chain, and their geographical proximity from the customer (Handfield et al., 1999; Wynstra, von Corswant and Wetzels, 2010; Schiele, 2006). A quantitative study by Peterson et al. (2003) suggest the following criteria to consider for companies seeking one of their suppliers for closer collaboration: 1. The supplier's ability to hit targets, 2. Ability to ramp-up capability, 3. Innovation and technical expertise, 4. Required training of personnel, and 5. Resource commitment on part of the supplier's top management team.

Studies have also investigated the advantages of supplier involvement. These have been studied in research from both the customer and the supplier's perspectives. As for the earlier these range from financial advantages such as reducing development, transaction, and manufacturing costs (Dyer and Ouchi, 1993), or strategic advantages such as increased efficiency, better access to technology and knowledge, and long-term alignment of technological strategies (Dyer and Ouchi, 1993; Bruce et al., 1995; Bonaccorsi, 1992). For the supplier, a positive effect of (extensive) involvement in manufacturers' new product development on suppliers' innovation and financial performance has been suggested (Chung and Kim, 2003). Also, collaborative innovation with manufacturers promises future rewards for suppliers and extends the level of collaboration with their customers (Heide and Miner, 1992).

When it comes to the subject of supplier involvement in innovation, research is still lacking, especially in the context of open innovation. In a wider context a study by Wynstra and Pierick (2000) identified four different forms of buyer-supplier development relationships. According to their study, these are Strategic development, Critical development, Arm's-length development, and Routine development. When development risk is highest, buyers aim to share this risk with their suppliers by involving them in the process and establishing direct communication and knowledge-sharing mechanisms, this is the case of strategic development. The other extreme is Routine development, where the risk associated with development is low and the focus is on ensuring timely delivery of previously agreed-upon prototypes. From among these forms of buyer-supplier collaboration it seems that open innovation practices are pursued when technological uncertainty is high, however open innovation research has yet to study this issue. According to a review of the state of empirical research on supplier involvement in NPD, Johnsen (2009) argues "There is a need to develop a greater understanding of the characteristics and management of ongoing supplier relationships within and between supplier involvement projects". He also takes note of the conflicting research on the benefits of supplier involvement in innovation. For example, research by Song and Di Benedetto (2008) on 173 recent radical new products suggested a positive relationship between supplier involvement and radical innovation. All while a recent empirical study on a large panel of Spanish innovative firms done by Belderbos et al. (2014) argues that manufacturers' collaborative innovation with suppliers tends to be incremental in nature and has a "problem-solving" background leading to relatively short research and development trajectories. While many studies confirmed a positive relationship, Su et al. (2009) do not find suppliers to contribute to innovation at all while Song et al. (2006) find collaborating with a supplier network to affect knowledge generation negatively. This confusion of results can be attributed to a number of factors. It

can be the result of what research has already established of the major difficulties which managers face preparing for such an engagement with their suppliers, hence making it difficult to determine whether collaborative agreements with them is generally positive in outcome. Von Corswant and Tunälv (2002) conducted a study on the collaboration between a Swedish auto manufacturer and five of its suppliers. While they also acknowledge the benefits which can be reaped from supplier collaboration, they shed some light on the seldom researched complexities and managerial challenges involved during the process. The authors suggest that collaborating with suppliers does not guarantee the customer access to its suppliers' competences and resources. This can be due to a number of reasons, such as the organizational structure of the supplier or a lack of necessary communication between the partners. The authors cite some studies to this effect, for example, Hartley et al. (1997) conclude that simply adopting the techniques suggested in the literature (on supplier involvement in NPD) will not necessarily reduce development time or lead to technical success in the project. Also Eizenhardt and Tabrizi (1995) found that supplier involvement could affect product development time negatively, especially when markets and technologies are rapidly and unpredictably evolving. Research done by Littler et al. (1995) showed that over 40% of the respondents expressed the view that collaboration makes product development more costly, more complicated, less efficient, more time consuming and more difficult to control and manage (Von Corswant and Tunälv, 2002). Other studies such as one by Johnsen (2009) lists some of the challenges of collaboration; including a need for internal coordination, advanced supplier selection processes, and long-term relationship adaptation to create supplier relationships with high levels of trust and commitment. Collaboration with suppliers also requires long-term adjustments between both organizations (Van Echetelt et al., 2008).

Moreover, and adding to the complexity of this mode of collaboration, the supplier may have a number of customers, some of them competitors to the firm. This introduces the management of the firm to the challenge of trying to compete for and appeal to the innovative supplier in order to win them over for collaboration. Nonetheless, this in turn runs the risk of making the supplier more powerful and selective, and hence reducing competition (Schiele et al., 2011). Also it runs the risk of a spillover of critical knowledge to the firm's competitors via the supplier (Von Corswant and Tunälv, 2002). Schiele et al. (2011) also suggest that one of the major obstacles for upstream open innovation is the buyer firms' fear that establishing suppliers as innovation partners may actually end up being too expensive for them in the sense that the supplier will become more powerful and thus charge them more. One of the aims of the research of Schiele et al. (2011) was to study whether by introducing a preferred customer status the supplier firm can alleviate some of those fears of

the customer. Nonetheless, these studies show that companies perceive a great deal of complexity when considering their suppliers for innovation, and that can translate to lengthy contractual agreements.

In conclusion, while collaborative innovation with upstream partners, suppliers in particular might seem intuitive since the parties involved in the collaboration are not unfamiliar to each other, the application of this existing relationship might be more complicated for exactly that same reason. Buyer-supplier agreements are designed to fulfil a specific set of objectives and for that reason; it might be more difficult to incorporate into this relationship a collaboration on other fronts such as innovation. Wynstra et al. (2010) argue that "the criteria for selecting, structuring, and coordinating a set of business actors for collaboration in manufacturing may not be the same as for structuring a set of business actors for collaboration in product innovation."

2.4.1.2 Technology suppliers

In our study of open innovation with technology suppliers, we are limiting our attention to universities and less so to research institutions. Universities are the most prevalent actor of this mode of open innovation, which has been a popular subject in academic literature. Research has investigated the various aspects of relationships between firms and universities, including ones that are focused on collaborative innovation. Moreover, it has been also studied within the context of open innovation (Perkmann and Walsh, 2007). Research's focus on universities as partners in innovation efforts is a reflection of the situation in practice. Several empirical studies marked universities as the most sought-after partner by firms looking beyond their boundaries for external sources of knowledge (Veugelers and Cassiman, 2005; Belderbos et al., 2004; Chiaroni et al., 2011). The attractiveness of universities as partners in open innovation is unsurprising due to the perceived lower complexity and risk associated with this type of open innovation relative to those with other types of partners such as competitors or suppliers. I will discuss this issue in more detail in the following sections.

On the benefits of engaging universities in innovation, an investigation by Belderbos et al. (2014) of a large panel of cross-industry Spanish innovative firms found universities or research institutions to be the only actors with whom firms positive effect on performance is likely in recently started innovative efforts. Meaning that within one year, firms can begin to reap performance benefits from this type of collaboration. The authors attribute this effect to the dual nature of collaborative research agreements with universities; on one hand the collaboration can be long-term oriented by engaging in front-end, basic research, but also

frequently focuses on short-term, technological problem-solving (Belderbos et al, 2014). Research also identifies universities as an important source of pre-industrial and/or pre-commercial knowledge. In this light, by drawing upon a survey of 1,489 SMEs, Vanhaverbeke and Brunswicker (2011) find that firms pursuing open innovation activities with universities did so in order to gain access to inventive, pre-industrial knowledge, as well as inventive trends. Similarly, Vanhaverbeke, Van de Vrande, and Chesbrough (2008) argue that engaging with universities in open innovation constitutes a process of option creation by which firms can effectively cope with high technological and market uncertainties. They also point to the flexibility this mode of collaboration can create by allowing firms to delay the financial commitment associated with initiating an innovation process within its closed walls with large up-front costs (Vanhaverbeke et al., 2008). In addition, firms protective of their intellectual property regard the low risk nature of collaborating with universities as an important incentive for collaboration. An in-depth case study of an Italian cement manufacturer by Chiaroni et al. (2011) found that when the firm embarked on adopting the open innovation paradigm, they did so by establishing long-term relationships with universities. The firm justified their choice of partner by citing the low risk of knowledge spillover when collaborating with universities relative to that involving suppliers, customers, or competitors. In fact, many studies have argued to that same effect, that collaboration with universities carries the lowest risk from among other potential collaboration partners (Santoro and Chakrabarti, 2002; Belderbos et al., 2014). Likewise an empirical study by Veugelers and Cassiman (2005) investigated data from 106 Belgian firms who have cooperative agreements with universities. Their findings do confirm the aforementioned low-risk nature of this mode of collaboration, describing it as involving “less appropriation issues, as compared to the more commercially sensitive content when cooperating in later development states, with customer, supplier, and competitors.”

Open innovation activities involving universities vary in their nature and characteristics. Perkmann and Walsh (2007) conducted a review of the literature on university-industry relationships. They found, based on 49 articles published from 1990 until the date of the study two main forms of relationship: research partnerships and research services. The earlier, research partnerships, is defined as an inter-organizational arrangement for pursuing collaborative R&D between a firm and a university (Perkmann and Walsh, 2007). While the latter form is of a transactional nature involving consulting and contractual research. It is important to highlight a distinction between the two forms which the authors point at. They argue that depending on the degree of finalization of their ongoing research, firms will find one of the two forms more suitable to their purpose (Perkmann and Walsh, 2007). Their finding is consistent with that of Belderbos et al. (2014) discussed earlier of the dual nature

of collaborative innovation agreements with universities. To elaborate on this point, in the later stages of their innovation processes firms may resort to contractual agreements with universities in order to acquire solutions to particular, well-defined problems; all while research partnerships can be a way to reduce uncertainty in the early stages of research or simply for the sake of pursuing knowledge itself (Weingart, 1997). Research partnerships have also been identified by other studies as one of the activities firms engage in with universities (Cohen et al., 2002; Schartinger et al., 2002) and in a finding similar to that of Perkmann and Walsh (2007), Vanhaverbeke, Van de Vrande and Chesbrough (2008) argue that this mode of open innovation is particularly applicable at the fuzzy front end of the innovation funnel in order to reduce the unacceptable technological and market uncertainties associated with this stage. Relationships therefore can be long-term oriented in this case (Perkmann and Walsh, 2007; Chiaroni et al., 2011). This mode of engagement with universities, research partnerships, is compared to other, less relational forms, such as the use of scientific publications and the licensing of university-generated IP (Perkmann and Walsh, 2007). In between research partnerships and research services, there exists an intermediate form of collaboration based on the mobility of individuals, whereby industry scientists and academics take up either permanent or temporary positions with the partner in the collaboration.

Another important aspect is the degree of innovation resulting from this mode of collaboration, being radical or incremental. Here, some studies suggest that it may spur the creation of radical, next-generation innovations (Tether, 2002; Belderbos et al., 2004). However, research done by Macpherson and Ziolkowski (2005) based on a case study suggests a positive impact of firm-university collaboration on incremental innovation. All while several studies describe the knowledge resulting from this engagement as pre-commercial, having no immediate application in industry (Cohen et al., 2002), as basic research aimed at reducing uncertainty (Vanhaverbeke et al., 2008), or as inventive, pre-industrial knowledge (Vanhaverbeke and Brunswicker, 2011). This discrepancy in research can be explained by the varied nature of firm-university engagements, which was pointed out earlier (Perkmann and Walsh, 2007). By collaborating with universities firms can pursue basic research at the front-end of the innovation funnel but also research aimed at problem solving late in the innovation funnel. The collaboration can also be for the sake of knowledge itself, or to build competences in technological areas non-core to the firm's business (Santoro and Chakrabarti, 2002).

The apparent simplicity of collaborative innovation agreements between firms and universities does not do away with some of the consequent complexities associated with

alliance management. The aforementioned study of Veugelers and Cassiman (2003) on Belgian firms characterizes this mode of collaboration as high in uncertainty, with high information asymmetries between the two partners, and as requiring high transaction costs for knowledge exchange (Veugelers and Cassiman, 2003). The generic nature of innovation with universities, they argue, makes it difficult for firms to appropriate the results of the research, and hence a knowledge spillover is still an issue. Firms should, in this case, focus on establishing an open and non-exclusive exchange with universities. Similarly, Vanhaverbeke and Brunswicker (2011) describe other barriers to innovation in firm-university relationships. These include cultural differences, conflicts resulting from the long-term oriented scientific research versus the exploitation-oriented research of industrial organizations, and incompatible reward systems with focus on publishing in universities versus "protecting" results in firms. So despite appropriability regimes not being a significant factor for cooperation with universities, as the study by Veugelers and Cassiman (2003) found, certain organizational change may be necessary (Chiaroni et al., 2010), such as the creation of an independent business unit to management the collaborative relationship and research contacts. It can also be argued that the degree of complexity involved in the relationship is dependent on the goals pursued as each of the different types of engagement described earlier may require a different arrangement.

2.4.2 Customers

Customer integration in the innovation efforts of companies is referred to in some studies as Collaborative Innovation with the Customer or CIC (Greer and Lei, 2012). Other studies refer to it more generally as customer co-production (Etgar, 2008) or customer co-creation (Payne et al., 2008; Piller et al., 2011). This mode of open innovation with a downstream actor in the firm's value network is defined as an "active, creative and social collaboration process between producers (retailers) and customers (users), facilitated by the company. Customers become active participants in an innovation process of a firm and take part in the development of new products or services." (Piller et al., 2011) Research on CIC has identified different types of actors who fall under the category of a customer. Thus a customer can refer to individual customers, firm customers, lead users, or community customers. Collaboration efforts differ with each of these customer types as will be discussed in more detail later.

In the context of open innovation research, collaborating with the customer in innovation has been established as one of the primary examples of open innovation (Gassmann and Enkel, 2004; Gianiodis et al., 2010; Chesbrough, 2011). And while the majority of research done on this form of open innovation indicates its positive impact on the firm's innovative

performance, fewer studies have investigated a comprehensive theory for CIC or a practical, managerial perspective of the process (Bogers et al., 2010). A review of CIC literature by Greer and Lei (2012) concludes that while the current theories on CIC provide an insight on why firms pursue this process, "they provide little guidance to how such innovation can be performed." I will review some of the research done on the motivation of both firms and customers to engage in collaborative innovation, and then I will review the research that has attempted to develop frameworks in order to organize and better understand its process.

The majority of studies reviewed agree that the demand for customization is one of the main driving forces behind the increase in CIC activities, especially in the mature markets of western and some east Asian countries where customers became no longer satisfied with standardized and mass produced products (Etgar, 2008). Other drivers for CIC include technological factors, which, through the introduction of mediums like the internet made it easier to establish relationships between firms and customers (Etgar, 2008). Also, CIC enables firms to reduce developmental risks by ensuring the meeting of their offerings to the needs of their customers (Greer and Lei, 2012). From the perspective of the customer, motives to collaborate with a firm on a new product vary from possible financial rewards from the firm to psychic rewards such as a sense of accomplishment or hedonic rewards such as enjoyment and fun (Greer and Lei, 2012). Despite the apparent straightforwardness of innovating with customers, some factors may inhibit this collaboration. For instance, certain it may only be feasible in some industries or product categories and not others since they would require the customer to have in-depth scientific or technical knowledge in order to contribute to innovation. This led some researchers to suggest that this engagement is focused on less innovative or incremental projects, while involving the customer to collaborate on highly innovative projects may prove to be "more trouble than they are worth it" (Campbell and Cooper 1999, p. 516). Nonetheless, the customer can be a valuable source of tacit knowledge, which can help firms improve on their products (Geer and Lei, 2012).

The customer involved in innovation can be an individual customer, a firm customer, or a community of users. Also, the process of CIC can be focused on the front-end of the innovation funnel or the back-end. Moreover, the leeway granted for the customer's input is also a variable since some firms employing CIC projects enforce certain guidelines and boundaries on users involved in the process; while other CIC projects allow the users more freedom to investigate more creative solutions. These three variables, the degree of collaboration meaning whether the collaboration is between the firm and the customer or between the firm and a community of users, the stage in the innovation process where

customer integration takes place, and the degree of autonomy of the customer in the process forms the basis of a framework by Piller et al. (2011) which aims to show the different modes and intensities in the ways firms can involve their customers in CIC. The front and back-end sides of the framework are shown below:

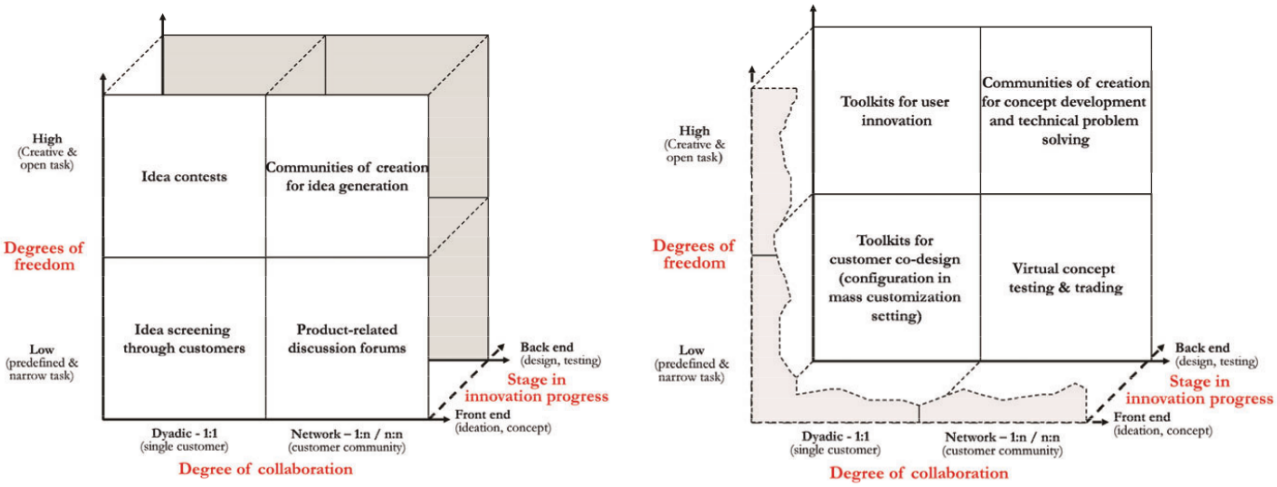

Figure 2. Front- and back-end customer involvement in innovation
Source: Piller et al. (2011)

It is not the purpose of this study to go into detail discussing the eight possible options for firms integrating their customers in CIC as proposed in the framework. I will, however, discuss the characteristics of collaboration on front-end projects as opposed to back-end collaborative innovation with customers. Here, authors of the framework cite a definition by O'Hern and Rindfleisch (2009) which suggests that innovation at the front end consists of two activities: (1) generating novel concepts and ideas, and (2) selecting specific concepts and ideas to be pursued further. In the case of firms collaborating with individual users the two activities are commonly pursued using idea contests and idea screening respectively, or in the case of user networks by tapping into discussion boards and communities of creation (Piller et al., 2011). Regardless of the method used, the collaboration ends with idea screening then the firm proceeds with the remaining stages of the innovation process independently after recognizing the winning ideas and awarding their authors. Back end co-creation can be said to require more effort on part of the firm in comparison with front end. This is due to innovation projects at this stage being more mature and requiring more technical collaboration on the part of the customer. Authors of the framework argue: "Here, customer inputs have to be more concrete and elaborated in order to be valuable for firms. A higher degree of elaboration often requires a more structured approach for the interaction with customers." When co-creating with individual customers, toolkits for user innovation and

co-design can be utilized while co-creation with networks of users can be pursued by utilizing peer production platforms such as crowdsourcing websites.

In summary, collaborative innovation with customers, in its different modes, is nowadays widely practiced by firms as their focus gradually shifted from the market as a whole, where customers are more or less "passive" actors in relation to the innovation process, to a new customer-centric orientation where customers are viewed as "the starting point of all activities" (Piller et al., 2011). And although there is a general consensus in literature on the benefits of customer co-creation, in reviewing the research we found three characteristics of this mode of collaboration that determine the nature of the collaboration and are noteworthy. Firstly, the type of customer involved in the process. Von Hippel, whose research initiated the trend of lead user co-creation (Von Hippel, 1986), suggested that not all users are equally equipped to participate in collaborative innovation with firms. He thus focused his popular research on lead users. In addition firms can collaborate with the general population of their customers and also with bodies of customer communities. The characteristics of the collaboration with each one of these customer types are different and in choosing from among these options firms must consider the nature of their industry, their customer offerings, and their customer base (Payne et al., 2008). Indeed, the knowledge of the customer can be a major inhibiting factor in this mode of collaboration, which might explain why co-creation is prevalent is some product categories and in some consumption situations and not in others (Etgar, 2008). A second important characteristic here is the dispensability of traditional organizational principles like contractual agreements and property rights, which can substantially lower transaction costs for firms (Piller et al., 2011). Also, the fact that customers self-select themselves to be involved in co-creation and assign to themselves specific subtasks befitting their skill also reduces the complexity of the transaction. These characteristics, on the whole positive to firms, can simultaneously introduce them to several risks. One being the risk associated with the difficulty of sustaining these efforts in the absence of a contractual agreement. A customer might simply lose interest and discontinue the collaboration, here the firm has to provide incentives for its customer partners and ensure their continued enthusiasm. This also makes firm-customer co-creation only viable for a limited amount of time. Other risks include customers becoming future competitors, or licensing their solutions to competitors of the firm (Greer and Lei, 2012). A third and important characteristic is that since customers show a natural resistance to radical innovation, their involvement in collaborative innovation tends to be biased towards incremental innovation (van der Panne et al., 2003). This tendency, in addition to the limited technical knowledge base of customers lead us to believe that this mode of open innovation normally results in incremental innovation.

2.4.3 Competitors

When considering firms that are normally engaged in ruthless competition decide to engage in open innovation, it may come as no surprise that this mode is considered the most risky for the parties involved (Ritala and Laukkanen, 2013). Yet and despite the risk, competing firms in many industries are coming together to cooperate on the research and development of new products and services. This apparent paradox of firms collaborating while in competition has been studied widely by researchers. The phenomena has been entitled "Coopetition" by Brandenburger and Nalebuff (1996) whose work applied the concepts of game theory to illustrate how collaboration and competition can be pursued simultaneously. The idea is to collaborate on increasing the size of the pie, then compete individually on dividing this created value. Coopetition has also been defined as the dyadic and paradoxical relationship that emerges when two firms cooperate in some areas, and at the same time compete with each other (Bengtsson and Kock, 2000).

Coopetition can include a range of activities; the focus of this study is on the activity of innovation. In this light, research has attempted, using case studies and less often empirical evidence to investigate the nature and outcome of this mode of coopetition. Reflecting on the definition by Bengtsson and Kock (2000), the paradoxical nature of collaborating with competitors on innovation can be understood as the need for knowledge sharing and simultaneously for instituting knowledge protection mechanisms. The management mechanisms at work behind these two activities are absorptive capacity and appropriability regime, respectively, whereby the earlier measures the firm's capacity for acquiring knowledge from across its boundaries. Absorptive capacity was conceptualized by Cohen and Levinthal (1990) as "the firm's ability to recognize, assimilate, and apply external knowledge in the context of innovation and learning processes". More specifically, according to Ritala and Laukkanen (2013) absorptive capacity has two important dimensions. First is the firm's ability to sense valuable intellectual assets, and the second is its ability to apply these assets to the firm's advantage. The later mechanism, referred to as appropriability regime by the same authors, sums up the strength of the different tools utilized by the firm in order to protect its core knowledge and innovations. The particular relevance of these two mechanisms when pursuing collaborative innovation with competitors has been suggested in research (Ritala and Laukkanen, 2013), and testifies to the complexity of this mode of coopetition, where the same authors suggest that knowledge similarity between the partners makes the risk associated with the collaboration even more pronounced. Indeed, a firm which partakes in a coopetitive innovation agreement may face an opportunistic partner (Nieto and Santamaria, 2007), one with a different strategic intent, or with more dire

consequences there can be a knowledge spillover, where the firm's weak appropriability regime allows knowledge not intended for sharing to leak to the partner, making a competitor yet more competitive (Ritala and Laukkanen, 2013). The significance of institutionalizing these two management mechanisms during coopetition was confirmed by an empirical study by Ritala and Laukkanen (2013) conducted on a total of 138 cross-industry Finnish firms who are involved in collaborative innovation with a competitor.

Nonetheless, despite the risks and complexity involved, firms are increasingly participating in coopetition. Their motivation, research suggests, can be an improved access to resources and markets, acquisition of knowledge and learning, reduced costs, and the sharing of risks, particularly in R&D (Nalebuff and Brandenburger, 1996; Bouncken and Fredrich, 2012). Whether collaboration on research and development is associated with incremental or radical innovation is a point of disagreement in literature. Here, some studies point to the fact that collaboration between the partners involved in this mode, being competitors who normally possess similar knowledge bases, can only lead to incremental innovation due to the lack of variety in knowledge needed for radical innovation (Crossan and Inkpen, 1995). All while Bouncken and Fredrich (2012) find, based on an empirical study of German IT firms that coopetition more strongly increases radical innovation than incremental innovation. Yet still, other studies suggest that coopetition, being characterized by mistrust and opportunism is not appropriate for the pursuit of innovation altogether (Bayona et al., 2001; Nieto and Santamaria, 2007).

This discrepancy in research on the outcome of coopetition on innovation has been investigated by a number of studies. Ritala and Laukkanen (2013), whose study on Finnish firms has been mentioned above, attribute the success and failure of coopetition to how strong the absorptive capacity and appropriability regime of each partner firm individually, and how they compare to the ones of their partner. On one hand their study confirms the importance of employing both mechanisms for the success of coopetition but also it points out how possessing strong absorptive capacities might lead to a learning race between the partners with the winner being the firm with the stronger one, in this case, not only is the trust between partners damaged, but it also can lead to a negative end-result for one of the partners. Heineman and Nickerson (2004) state, referring to this situation where "the value created by the collaboration from transferring knowledge may be eclipsed by the value of the knowledge expropriated." Likewise, building strong fences to protect the firm's core knowledge is crucial, but can also become an obstacle to innovation (Dosi et al., 2006). Hence it can be argued based on this study that firms who succeed in cooperation achieve the delicate and correct balance of these mechanisms. Other research attributes this

variation in research to the fact that coopetition's success depends not only on firm-specific factors, but also on environmental ones where variables such as market uncertainty, network externalities, and competitive intensity play an important role in determining the likelihood of cooperation success (Ritala, 2012). Other, more subtle factors can also affect the process and outcome of coopetition. An empirical study by Boucken and Fredrich (2012) found that factors in the relational context of the coopetition, namely the levels of trust and dependency between partners playing a role in both the way firms organize for coopetition and on its end result. For example, their results suggest that firms in coopetition achieve better performance with incremental innovation in situations of high trust and high dependency, where one of the parties involved is superior and has a dominant position in the relationship.

The complexity involved in collaborative innovation with competitors is by no means unanticipated. To characterize it based on the literature reviewed, this mode of open innovation involves a risky exchange of knowledge which can be used in both collaboration and competition, making the end result a positive-, neutral-, or even a negative-sum game for the parties involved (Ritala, 2012). Hence it is with a great deal of caution and consideration that firms embark on open innovation with a competitor. Testifying to this is the importance research attaches to institutional protection mechanisms that help ensure the safe transfer of knowledge and safeguards intellectual property rights (Ritala and Laukkanen, 2013). Patents, copyrights, trade secrets, extensive contracts, and labor legislation are formal methods utilized by firms to achieve this purpose. Informal methods such as secrecy, complex design and lead-time can also be beneficial (Rammer, 2002). In addition, Boucken and Friedrich (2012) draw from alliance management to suggest the necessity of a dedicated alliance function in which specialists are employed to regulate external relationships and increase the likelihood of their success. As a result, open innovation with competitors can be a taxing process on the resources and management of the firm (Ritala, 2012; Boucken and Friedrich, 2012). With regards to the type of innovation pursued in coopetitive innovation agreements, some studies argue in favor of incremental innovation while others in favor of radical innovation. Ritala and Laukkanen (2013) hint at an important characteristic of this mode when they argue that coopetition is typically conducted in the early stages of the value chain, away from the customer. They attribute this to the increasing competitive tendencies when firms move closer in the value chain to the customer. In this case, competition takes over the relationship between the partners and decreases the chances of success.

2.4.4 Complementors

The role of complementors in the value net of firms has been studied mainly in the general terms of value creation (Nalebuff and Brandenburger, 1996; Dyer and Singh, 1998; Kapoor, 2013). Very few studies have been more particular in analyzing the relationship between firms and their complementors (Habets, 2012). In the context of open innovation, no research was found investigating complementors. In their book on open innovation, Chesbrough et al. (2006) point to the importance of closing the distances between the firm and the various actors in its value network, including complementors, but the authors also discuss this in the terms of creating and capturing value from these relationships and do not shed light on the particularities of open innovation efforts with complementors. Firms do however, as an empirical study on 1,489 European SMEs suggests, engage in collaborative innovation with their long-term complementor partners (Brunswicker and Vanhaverbeke, 2010). Also, a survey of 99 firm-complementor relationships from 51 firms in the semiconductor industry found sharing information, on R&D and markets, and joint product development to be activities these firms engaged in with their complementors (Kapoor, 2013).

Nalebuff and Brandenburger (1996) were the earliest who using the principles of game theory argued for the benefits firms can gain from collaborating with actors along the horizontal axis of their value net, those actors being namely the firm's competitors and complementors. They define a complementor as a player whose product offering leads customers to attach a greater value to the firm's own products relative to the value they attach to those products on their own. In other words, "Complementors are companies that independently provide complementary products or services directly to mutual customers" (Yoffie & Kwak, 2006, pp. 89-90). Complementors are important actors in the firm's value net. In fact, the popular model of Nalebuff and Brandenburger (1996) establishes a symmetry between competitors and complementors. Understanding the business of complementors, in order to provide customers with better value, is therefore as important for the firm as understanding the business of their competitors (Gupta et al., 2007).

Due to the lack of research on the nature of collaborative innovation agreements between firms and complementors I will review in the following paragraphs what research suggests as the motives for the pursuit of this mode of open innovation and also, based on the unique characteristics of complementors in the value net of the firm, predict the nature of collaborative agreements with them and the risks involved in the process.

Motivating firms to collaborative innovation with complementors can be the access to new ideas and technologies (Brunswicker and Vanhaverbeke, 2010). Since complementors in many cases operate in different industries from the firm, the knowledge obtained from them is more diverse than that of suppliers or competitors. This diversity of knowledge is crucial for innovation, especially for the creation of novel ideas and concepts, which may lead to radical innovation (Habets, 2012). Also, involving complementors in the innovation process can lead to a better performance of the firm's products (Kapoor, 2013).

Since no research was found investigating this mode of collaborative innovation, our aim is to use the general characteristics of collaboration with complementors in order to portray the possible issues involved in engaging in open innovation efforts with them. Foremost, complementors are not all equal to the focal firm. Some research suggests a degree of complementarity (Casadesus-Masanell and Yoffie, 2007) onto which depends the decision to collaborate and the level of collaboration sought by the firm. Complementors also vary in their competitive threat, some being close enough to the firm's business to make value appropriation measures necessary to protect knowledge not intended for sharing (Kapoor, 2013). Complementors also compete for the value created where each tries to capture the maximum share of profit from the mutual customers (Nalebuff and Brandenburger, 1996). Hence it can be inferred that the relationship between complementors is increasingly competitive as it advances down the value chain, less so in the earlier stages. Yet collaboration is also vital in the downstream. For example, coordination on the timing of product release is a usual practice (Kapoor, 2013). So when firms decide to collaborate with complementors on upstream operations (such as R&D) the relationship will probably extend for the length of the value chain all the way to the customer. The length of the relationship and the resulting involvement of several departments within the firm may require dedicated organizational units to manage the collaboration. This is confirmed in the findings of the empirical study of Kapoor (2013) where the extent of collaboration was found highest when a dedicated unit was in charge and lowest when managing the collaboration was left to the engineering department. The study also suggests that firms may need to redesign their internal organization to facilitate better collaboration.

Collaborative efforts with complementors are not risk-free. Apart from the conflicts associated with downstream activities, such as conflicts over pricing or the timing of product release, the risks associated with collaborative innovation in particular are not addressed in literature. We can infer, however, that depending on the degree of complementarity between partners the risk of losing valuable knowledge to the complementor can be relevant during

collaborative innovation, especially when the complementor can also be partners with a competitor firm.

2.5 Open innovation outside the value net

This section of the study will review the research done on open innovation when pursued with actors outside the value net of the firm. In this category we will investigate the role of distant firms, ones whose business offering is unrelated to that of their partners' in open innovation. Empirical evidence suggests these actors are less popular as partners in collaborative innovation comparing to partners from within the value net of firms. As the literature review will show, this may be attributed to the main characteristic of these relationships being the cognitive distance between partners. Indeed, unlike partners from within the value net, here an asymmetricity of information exists can act both as a barrier for collaboration but also as a window of opportunity. It seems, however, that many firms still perceive this distance as a deterrent rather than an incentive. Nonetheless, research has discussed possible implications of the asymmetric nature of these partnerships. 1. It may constitute a motive for firms to pursue open innovation with those types of actors, since they perceive them as less risky relative to other options. 2. It may explain the exploratory nature of these relationships being focused on frontend activities early on in the innovation process such as idea generation, evaluation, and idea selection. 3. It characterizes these relationships as ones with high levels of uncertainty. 4. The complexity of agreements between partners in this mode of collaboration is lower relative to collaboration with other types of partners. 5. It leads to knowledge diversity that may act as a barrier between partners but also as an incentive since it facilitates the creation of novel and break-through innovations.

With cross-industry firms:

This mode of open innovation takes place when firms from separate industries engage in joint innovation efforts. Here, none of the firms involved are actors in the value net of the other firm(s), as they are not suppliers, customers, competitors, or complementors. This distance between firms is the main characteristic of this application of open innovation and explains the light under which it is viewed in research. Due to this distance, literature has attempted to investigate the reasons why firms engage in this form of collaboration and how they search and identify potential partners for collaboration. Research's focus, hence, has been on the early stages of the innovation process. More specifically, the scope of research on this subject was found to imply that open innovation with cross-industry partners is relevant in the early stages of the innovation process, and namely to the activities of idea

generation, evaluation, and selection. Depending on the characteristics of a mode of open innovation, certain firm-level capabilities are more pronounced in the literature on the subject. In this case the capability of analogical thinking is highlighted, as well as the firm's absorptive capacity, albeit here it is applied across-industry boundaries. Cognitive distance is also a concept that is prevalent in the literature on the subject. I will use the next sections to review these concepts as well as the motivation and process of pursuing this mode of open innovation.

A European inventor survey by Giuri and Mariani (2007) suggests based on evidence from 8,180 observations that actors within the value chain of the firm still constitute the most popular partners for firms looking beyond their boundaries for external sources of knowledge. The main difference between value-chain partners, being customers, competitors, or suppliers on the one hand and firms outside the value chain (also excluding complementors) on the other is the difference in the cognitive distance involved. Enkel and Gassmann (2010) attribute firms' reluctance to engage in open innovation activities with firms outside their value chain to this particular reason, citing several studies suggesting that firms mostly regard the great cognitive distance associated with this type of collaboration as a threat instead of an opportunity (Enkel and Gassmann, 2010). To better understand the reasons behind this perceived threat, we cite a definition of cognitive distance by Nooteboom and Vanhaverbeke (2005) as a term capturing "the differences in the cognitive and cultural 'focus' of the firm, which consists of shared perspectives, values, norms of conduct and stock of knowledge and technological capabilities." While the difficulties firms may perceive in overcoming this distance can be justifiable, an increasing number of studies suggest that this same distance can actually have a positive effect on innovation performance (Brunswicker, 2010; Enkel and Gassmann, 2010). These studies build on extant research confirming a positive impact of diversity, or "breadth", in external knowledge sources on the innovation performance of firms (Laursen and Salter, 2006). According to Brunswicker (2010), "greater degrees of cognitive distance tend to yield opportunities for highly novel solutions." Similarly, empirical research done on patent data from 994 alliances by Nooteboom and Vanhaverbeke (2005) suggests an inverted U-shape relationship between cognitive distance and both innovation performance and the novelty in innovation. The greater the cognitive distance between partners the greater are the chances for highly novel solutions, however at some point cognitive distance can be so great to the point of becoming a hindrance to innovation. We hence argue that taking advantage of knowledge diversity resulting from cognitive distance is a motive for firms to pursue this mode of open innovation. Similarly, the decision for cross-industry collaborative innovation may also be driven by environmental factors, such as situations of industry convergence. In this light,

Bröring et al. (2006) conducted an exploratory study on the pharmaceutical, speciality chemistry, and food industries which as a result of their convergence are creating new inter-industry segments at the boundaries of these otherwise distinct industries. These emerging sectors, such as the nutraceuticals and functional foods (NFF) sector are bringing the pharmaceutical industry, traditionally focused on curing, and the food industry, traditionally focused on nurturing, together. The study found no homogenous reaction in the investigated firms facing prospects of industry divergence, it did, however, identify a group of firms who in order to overcome their path-dependency and lack of capabilities required in the new inter-industry segments, resorted to cross-industry collaboration with external partners in order to acquire this knowledge (Bröring et al., 2006). A case study by the same authors describes how a firm active in speciality chemical ingredients decided to enter the dietary supplements market through an engagement with a food company. In this case, the authors argue, the earlier firm utilized this collaboration to gain market capabilities and ideas from the food manufacturer that serve as inputs to the front end of its own innovation process. Cross-industry open innovation, hence, can also be motivated by the desire to enter new and emergent segments.

A process of cross-industry innovation has been described by Gassmann, Daiber, and Enkel (2011) as consisting of three main steps: abstraction, analogy, and adaptation. Their model was developed based on interviews with German and Swiss-based intermediary firms who provide support to companies in their innovation activities. The activities associated with the stages in the model are described as follows: First is the Abstraction Phase: during this phase the firm must develop a diagnostic view of its competences and needs. Second is the Analogy Phase: here the firm has to search externally and identify potential solutions to its problems. In describing this second phase it is important to stop at an important capability, called analogical thinking, which the firm must apply in order to be able to conduct this search for knowledge across its industry boundaries and therefore a capability that is particularly relevant when pursuing cross-industry collaborative innovation. Gentner et al. (1993) define analogical thinking as the process of transferring information from a familiar setting to a new setting by using creative tasks. In a process where firms must be able not only to identify potential solutions and opportunities in distant industries but also to adapt these ideas to their own application, it is foreseeable how analogical thinking, which enables the transfer of a concept from one industry to another (Dahl and Moreau, 2002) is at the heart of cross-industry open innovation. In fact, Brunswicker (2010) argues that the search among distant knowledge domains is rooted in conceptual discussions on “analogical problem solving.” Other studies have identified this capability as beneficial to corporate success (Gavetti et al., 2005) and as a source of radical innovation (Holyoak and Thagard,

1995). The third phase in the process is the Adaptation Phase: here the firm adopts the solution found in the second phase and may decide to pursue collaborative innovation efforts in order to adapt the solution to its needs or it can pursue other means by which it integrates the solution into its internal innovation process. The above-mentioned example from the research of Bröring et al. (2010) described how a joint venture was established by the two firms from the chemical ingredients and food industries in order to pursue the development of products once the search for promising ideas had been completed.

The process of Gassmann et al. (2011) described above is also testament of the overwhelming focus by researchers on the challenge of external exploration and search when investigating how firms pursue cross-industry innovation. Another example of this is a study by Brunswicker (2010) addressing the question of how firms can search for innovation inputs in the fuzzy, front-end of the innovation process. Brunswicker justifies this focus by stating "The ideation phase is the core activity of a cross-industry innovation project." Nevertheless, cross-industry innovation can facilitate outbound open innovation as well. Enkel and Gassmann (2010) argue that cross-industry innovation can be used as a tool for transferring technologies to foreign industries, as well as an opportunity for monetary benefits from licensing and patents. This last effect is conceivable since gaining knowledge of foreign industries can help firms discover new potential applications of their own technologies in those industries and which consequently can present those firms with opportunities to either pursue the development of these applications themselves, in collaboration with others, or use a facet of outbound open innovation in order to transfer this knowledge to others. No other research was found investigating the particularities of this inside-out aspect of cross-industry innovation.

Needless to say, cross-industry open innovation carries with it its own complexities and potential challenges. Due to what the literature points at of the mainly exploratory nature of collaborating with a cross-industry partner, it is unsurprising that high uncertainty is characteristic of this mode of collaboration (Segrestin, 2005). Research done by Gillier et al. (2010) also on exploratory partnerships sheds some light on the complexities involved in this process. They argue that the different strategies, needs, and competences among the partners, as well as the diverse range of knowledge involved, present an acute managerial challenge to the partner firms. This, along with other risks such as opportunistic behavior and information asymmetry may explain the low rate of success associated with such engagements (Gillier et al., 2010). Therefore the importance of formal contracts between partners as a means of establishing trust is highlighted. This in turn, however, is challenging due to the difficulty anticipating the results of collaboration. The same authors cite a study by

Blomqvist et al. (2005) which suggests that contracting is more challenging between companies from different backgrounds than between companies with similar characteristics and cultures. A potential solution is suggested by Gillier et al. (2010) where routine revisions of the conditions of engagement are institutionalized in order to maintain a successful relationship between partners. Nevertheless, the growing enlisting of the services of an increasing number of firms specializing in intermediary innovation and knowledge brokerage may testify to the complexities involved during this process, which may also require new or adapted processes, tools and competences in technology, and innovation management. (Gassmann et al., 2011; Gillier et al., 2010; Enkel and Gassmann, 2010).

2.6 Review summary

2.6.1 Open innovation with value net actors

	Stage of involvement in the innovation funnel	Degree of innovativeness	Complexity	Risk
Market suppliers	-No research was found in the context of OI. -In the more general terms of NPD, Several possible points of involvement (Handfield et al., 1999)	-"Problem-solving" background and tending to be incremental in nature (Belderbos et al., 2014). -Neutral effect of supplier involvement in innovation (Su et al., 2009) -Negative effect of supplier involvement (Song et al., 2006)	-Need for internal coordination, an advanced supplier selection process, long-term adjustments between both organizations (Van Echetelt et al., 2008).	-Risk of making the supplier more powerful and selective when established as a strategic or development partner, thus charging the firm more for components (Schiele et al., 2011). -Spillover of critical knowledge to competitors via the supplier (Von Corswant and Tunalv, 2002).
Technology suppliers (Universities)	-Dual nature agreements: can be long-term oriented focused on the frontend or problem solving oriented in the later stages of the innovation process (Belderbos et al., 2014), (Perkmann and Walsh, 2007). -Applicable at the fuzzy front end of the innovation funnel (Vanhaverbeke et al., 2008).	-May spur the creation of radical innovations (Tether, 2002), (Belderbos et al., 2004). -Incremental innovation (Macpherson and Ziolkowski, 2005). -Inventive, pre-commercial knowledge (Cohen et al., 2002), (Vanhaverbeke and Brunswicker, 2011), (Vanhaverbeke et al., 2008).	-High in uncertainty (Veugelers and Cassiman, 2003). -Due to the asymmetricity between partners, high transaction costs can be a result (Veugelers and Cassiman, 2003). -Certain organizational change may be necessary (Chiaro et al., 2010).	-Low perceived risk of knowledge spillover (Chiaroni et al., 2011). -Involves less appropriation issues (Veugelers and Cassiman, 2005).

Customers	-Depending on the objective of the firm, customers can be involved in the frontend or the backend of the innovation process (Piller et al., 2011).	-Geared towards less innovative or incremental projects (Campbell and Cooper, 1999) -Customers show a natural resistance to radical innovation, so their efforts tend to be biased towards incremental innovation (van der Panne et al., 2003).	-Dispensability of contractual agreements and property rights, making collaboration less complex and lowering transaction costs (Piller et al., 2011). -Customers assign themselves to specific subtasks reducing complexity (Piller et al., 2011). -Collaborating tends to be short-term due to the difficulty sustaining efforts with customers. (Piller et al., 2011).	-Customers becoming future competitors, or licensing their solutions to competitors (Greer and Lei, 2012).
Competitors	-No research was found in the context of OI. However, in the general terms of NPD, competitive tendencies increase down the value chain towards the customers. So collaborative efforts are conducted in the early stages, as far from the customer as possible. (Ritala and Laukkanen, 2012).	-Disagreement in literature: 1. Due to the similarity in knowledge bases, it can only lead to incremental innovation (Crossan and Inkpen, 1995). 2. Bouncken and Friedrich (2012) find a greater increase in radical innovation than incremental innovation. 3. Bayona et al. (2001), Nieto, and Santamaria (2007) suggest a negative outcome of collaboration.	-Mechanisms for knowledge appropriation are indispensable (Ritala and Laukkanen, 2013). -Importance of both formal protection mechanisms like patents, copyrights, and extensive contracts, as well as informal ones such as secrecy, complex design and lead-time (Rammer, 2002). -High transaction costs, including the suggested need for a dedicated alliance function. (Ritala, 2012; Boucken and Friedrich, 2012).	-High in risk due to: 1. Knowledge similarity. 2. Possibility of a knowledge spillover. Making the competitor more competitive. 3. Consequences of facing an opportunistic partner, or one with a different strategic intent (Nieto and Santamaria, 2007). 4. Can be negative-sum game for one of the partners (Heineman and Nickerson, 2004; Riatal, 2012).
Complementors	-No research was	-The diversity of	-Depends of what the literature	-Since

	found.	knowledge among partners can lead to radical innovation (Habets, 2012).	suggests as the "degree of complementarity" (Casadesus-Masanell and Yoffie, 2007). -Knowledge appropriation measures may be necessary (Kapoor, 2013). -Since collaboration with complementors normally takes place in downstream activities, collaborating on upstream activities such as R&D can lead to an engagement that extends to many stages in the value chain. -May require a dedicated alliance function or redesigning internal organization (Kapoor, 2013).	complementors can also be partners to competitor firms, there exists a risk of a knowledge spillover.

Table 4. Characteristics of open innovation with value net partners

2.6.2 Open innovation with distant companies

	Stage of involvement in the innovation funnel	Degree of innovation	Complexity	Risk
Distant firms	-Overwhelming focus on the frontend activities of the innovation process (Brunswicker, 2010), (Gassmann et al., 2011).	-High in novelty due to knowledge diversity. Brunswicker (2010). Nooteboom and Vanhaverbeke (2005)	-High uncertainty (Segrestin, 2005). -Due to the diverse range of knowledge involved, some management challenges may ensue (Gillier et al., 2010). -Importance of formal contracts to establish	-Risk of opportunistic partner (Giller et al., 2010).

			trust between partners. Also the routine revisions of these contracts (Giller et al., 2010). -May require new or adapted management processes, particularly in innovation management (Gassmann et al., 2011).	

Table 5. Open innovation outside the framework of the value net

Chapter 3 - Methodology

To lay the empirical foundations of my study, I adopted the approach Eisenhardt and Graebner (2007), who state: “Sound empirical research begins with strong grounding in related literature, identifies a research gap, and proposes research questions that address the gap.” In following this approach, I started with a thorough review of the research done on open innovation frameworks as well as on the nature of open innovation endeavors when on the one hand conducted with partners within the value net of firms and on the other with partners from outside this value net. In line with the approach of Yin (2009) who suggests the use of the literature review not as an end in itself, but instead as a means to an end. Reviewing this literature left no doubt of a pressing need for more structuring in the academic study of open innovation. It was also clear that research on this topic has left unexplored the general phenomenon of the variation in open innovation agreements relative to the type of partner with whom they are conducted. Therefore a gap in literature was identified and research questions were developed in order to address this gap. To answer these questions an exploratory study based on case studies will be conducted. My guides for conducting this type of research are Case Study Research, a book by Yin (2009), as well as a paper on theory building from cases by Eisenhardt and Graebner (2007). Case study research has been defined by Yin (2009) as an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context. It is also, according to the same author, a research method that can be used for exploratory, descriptive, or explanatory purposes as it also allows for pattern recognition of the central constructs and relationships of the phenomenon in question (Eisenhardt and Graebner, 2007). Yin (2009) also recognizes case study research as one that allows for the retaining of the characteristics of organizational and managerial processes, which is particularly befitting of my study. Even more so is what Robert Stake describes in his book The Art of Case Study Research (1995) as the valid utilization of case study research to modify grand generalizations. Here, it may be used to reveal complexities or variations in a phenomenon that is otherwise traditionally presented in a simplistic form (Stake, 1995). Since we believe this to be present in the academic study of open innovation, we adopt this methodology with the goal of particularization, instead of statistical generalization. Hence it is the combination of these characteristics, in addition to the lack of viable theory due to open innovation being a relatively recent field of study still lacking in conceptual development (Huizingh, 2010), that provide the justification for my use of this research method.

The next question to consider is whether to conduct a single-case study or a multiple-case study. Here I opted for the latter not only because it provides a stronger base for theory building (Yin, 1994) but also since my study aims to investigate a possible polarization in open innovation practices; this aim dictates the need for multiple cases and is also a factor in case selection since data must represent both supposed 'polars'. This research design is described as a "two-tail" design (Yin, 2009) where extreme cases are deliberately chosen in order to show contrasting patterns more easily. Eisenhardt and Graebner (2007) refer to this sampling approach as "polar types" and confirm its utility. Applying this approach to my study, a conscious attempt was made to select distinct case studies with significantly different applications of open innovation. As a result, the cases covered consisted of a multinational firm with a centralized open innovation program aimed at diversification into emerging business areas, another investigated a firm with a similarly managed program but one aimed at exploring novel solutions in existing business areas. A third case involved a firm where open innovation was embraced s the result of an initiative by a group of employees at the firm, therefore typifying a "bottom-up" process of open innovation and one where the outcomes sought are of a lesser strategic significance. Moreover, the case of a company at yet an earlier stage in the process of opening up its boundaries for knowledge flows is presented. In each of these unique cases a close attention was given to the partners whom the companies sought for open innovation. Were they value net partners or more distant companies? Therefore our first polar type is open innovation within the value net while the second is open innovation outside the value net. Hence I will provide case studies for each of these two cases. This approach to case selection is also supported by theory which suggests that the choice of cases should not be random but instead should rely on factors such as the uniqueness of a given case or its contribution to theory development (Eisenhardt and Graebner, 2007). Yin (1994) mentions other possible basis for case selection such as replication, the extension of theory, and contrary replication. This logic of multiple-case study research is shown in the figure below:

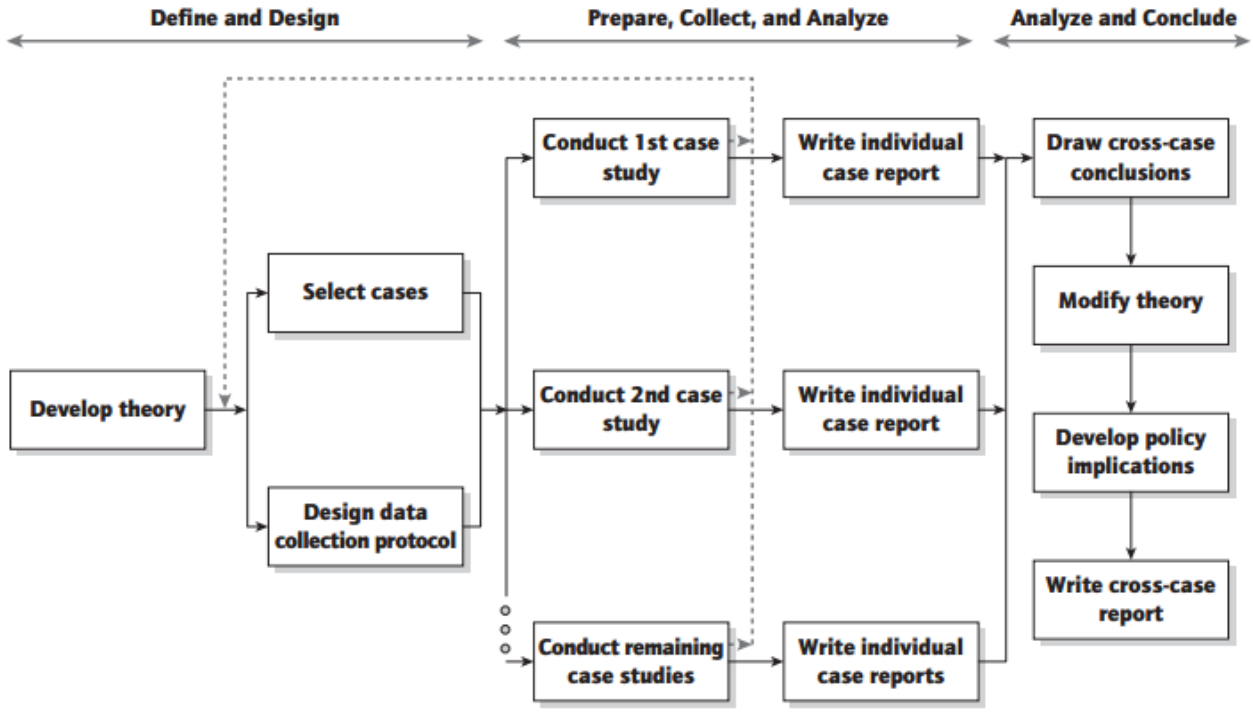

Figure 3. Case study research
Source: Yin (1994)

Each individual case study is treated as a whole study, where convergent evidence and conclusions are sought (Yin, 2009). The results are subsequently replicated in following case studies. Here, a correct application of replication is important to the validity of my study. The idea is to explain, while conducting the replicated case studies, why these cases were predicted to have certain corroborating results while other cases were predicted to have contrasting results. This information, which Yin (2009) calls the extent of replication logic across cases, will be included in the summary report.

Our data was collected from multiple sources whenever possible, but mainly through in-depth, semi-structured interviews with the managements responsible for open innovation at each of the investigated companies. Furthermore, documentation describing these programs was gathered from various sources including company websites as well as previous research that may have used the company as a case study as well. Relying on multiple sources of data strengths the theoretical foundation of the study (Eisenhardt, 19889), and is a case study tactic prescribed by Yin (2009) to increase construct validity. Moreover, a case study database was developed to include transcripts of the interviews conducted.

Chapter 4 - Case studies

4.1 Individual case assessments

4.1.1 Case: DSM (The Dutch State Mines company):

This case study was based on data collected through a study of the documentation on DSM's open innovation program as well as my interview with Mr. Robert Kirschbaum, VP of Open Innovation at Royal DSM.

Mr. Kirschbaum's office is located at the company's Innovation Center and where it develops the competences necessary for its growth in long-term and strategic business areas. These strategic areas, called Emerging Business Areas or EBAs are the focus of the Innovation Center whose objective is to develop the infrastructure and knowledge required to turn these EBAs into New Business Groups (NBG) of DSM within a timeframe of five to ten years. The center is hence physically separated from the existing and ongoing business groups of DSM and it is from here that open innovation is managed. Stationing its open innovation activities in the innovation Center, that is, separate from its ongoing business functions hints at DSM's understanding and application of the innovation paradigm, namely as one best applicable to strategic areas of high business uncertainty and high risk which DSM labels as EBAs. To quote Mr. Kirschbaum:

> "What we have learned is that open innovation works better when you are further away from the established products and business lines. Why? An emerging business area, where the subject is new to DSM, new to the world, where the market is emerging so it can go anywhere, we don't know which product/market combination is going to lead us to profitability, we see many uncertainties, there are so many questions, that we are willing to share with others."

Our first observation therefore is that DSM utilizes open innovation for radical and break-through (or break-away) directions all while maintaining a more conservative approach to innovation within its existing business functions, which have their own objectives for growth and innovation and where 80 percent of DSM's innovation actually takes place. To further illustrate this application of open innovation, the VP used the example of Caprolactam, the commodity chemical that was historically central to the growth of DSM, Mr. Kirschbaum cited the company's strong market position to conclude: "We may lose more in sharing than we

may win." Hence, DSM's openness varies depending on factors such as the level of uncertainty associated with a particular product/market combination. We can further illustrate this using the model grid shown below and which was initially developed by Royal Philips and later adopted by Royal DSM. The grid classifies DSM's activities based on the disruptiveness of the product and the market life cycle.

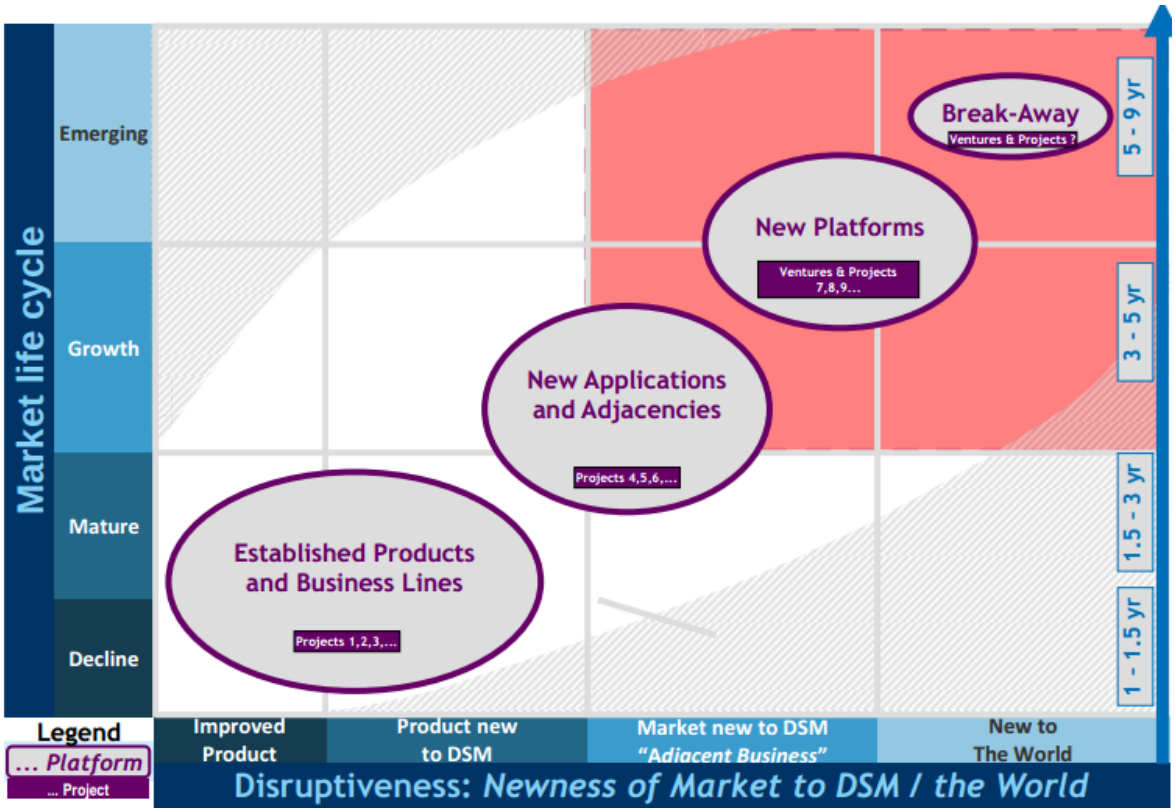

Figure 4. DSM's business activities
Source: DSM documentation

Considering openness in light of this grid, Mr. Kirschbaum view is that open innovation works best in the upper-right corner where DSM aims to develop completely new products in emerging markets, as a reason for this he cites the high technological uncertainty and risk associated with this type of innovation, and which pressure firms to share more knowledge with their innovation partners. This view also appears consistent with the way DSM applies open innovation in its Innovation Center, utilizing it towards exploratory research all while incremental improvements on existing products usually take place in the company's business functions, outside of the its Innovation Centre and thus not necessarily open to external partners. When asked if the degree of innovation sought can hence be integrated to the model where incremental innovation is near the origin and increasing in novelty to radical innovation in the upper-right corner, Mr. Kirschbaum agreed to this analogy. We conclude that the degree of innovation sought is related to the managerial considerations associated with implementing a certain innovation strategy. For example, when referring to areas on the grid closer to the point of origin, Mr. Kirschbaum stated that closed innovation is

preferred. Reflecting on our research goals, is partner type a factor that can be integrated as well into this model? We can proceed with an analysis of DSM's open innovation partnerships involving actors from within its value net and later those involving distant partners.

DSM and its value net partners:

In constructing the value net of DSM the following points are noteworthy. DSM is a business-to-business company (i.e. not active in end markets). Also, DSM is active in different industries, so its value net partners vary depending on business area and market. For example, in the emerging business area of advanced biofuels, DSM's suppliers include agricultural companies supplying corn harvest waste. Its competitors here are large energy companies whose business of fossil fuels is under threat by alternative energy sources. Its complementors would include a variety of actors who by pursuing their business independently of DSM can improve the value of its alternative fuel offering such as the complementary role auto manufacturers can play when adapting their vehicles to this new technology, also complementary is the role governmental agencies and nongovernmental organizations advocating alternative energy. Hence a unique value net can be drawn for each of DSM's Emerging Business Areas. An example value net, that of advanced bio-fuels business area is shown below:

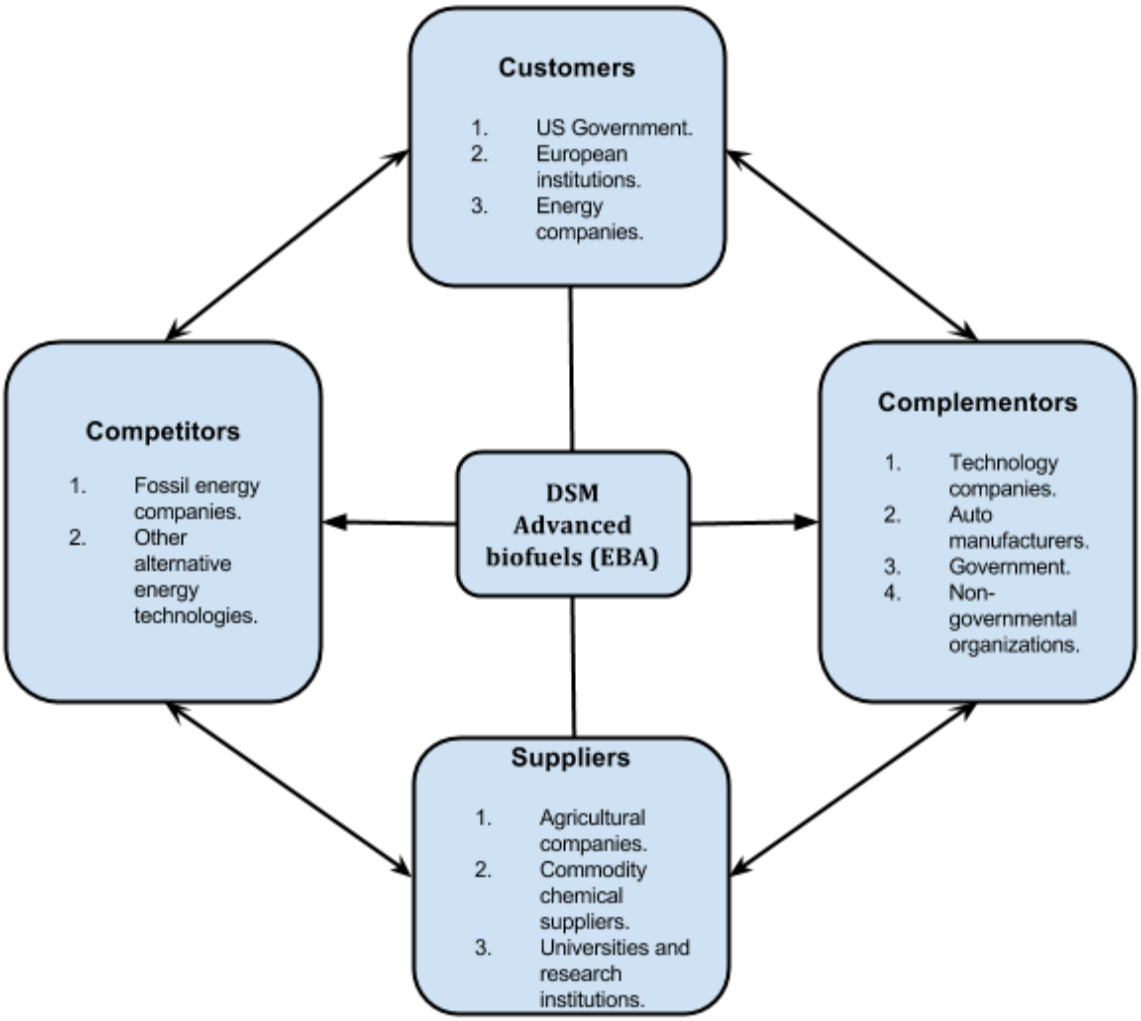

Figure 5. DSM's value net
Source: Own projection (adaptation of the value net scheme developed by Nalebuff and Brandenburger (1996))

With market suppliers:

Open innovation between DSM and its market suppliers is limited to incremental improvements on the suppliers' offering, and interesting to DSM only when the volumes involved are substantial enough that the financial effects of these small improvements would be felt by DSM, or using the VP's words would "move the needle of DSM". Here he also raised the issue of DSM's loyalty to its suppliers, citing the disparity of power in these relationships:

"*If they do not agree we go to another supplier*"

With technology suppliers:

When establishing partnerships with universities, DSM looks for access to talented scientists at these institutions. So Mr. Kirschbaum pointed to a recruitment element in collaborating

with universities. Additionally, when asked why he considers universities and research institutions as particularly suitable partners in DSM's EBAs, he noted that universities and research institutions are driven by ideology, making some of them particularly fitting as partners in long-term, strategic innovation. This is consistent with our expectation of the differences in collaborating with profit-oriented industry partners and whose pursuit of innovation can be driven by non-pecuniary reasons.

With regards to the complexity involved when dealing with universities Mr. Kirschbaum cited difficulties in IP agreements. Universities would like to profit from licensing their patents, while DSM tries to avoid this since in emerging business areas, the value that can potentially be reaped from buying patents is difficult to assess early on in the process and moreover, pending patent applications can be challenged by other parties and consequently refused.

With customers:

DSM is a B2B company and is not active in end markets. This limits its collaborative innovation with customers to industrial ones, which according to our review of existing literature is distinctive from collaborative innovation with end users. Nonetheless this allows DSM to collaborate with its more immediate industrial customers on what best meets the needs of the customer's customer. This typically takes place, according to Mr. Kirschbaum, in later stages of the innovation process and mainly using pilot prototypes of products. These are sent to the customer and modifications can then be made upon request. This mode of collaboration, the VP explains, is less risky relative to innovating with suppliers, where financial considerations overrule a lot.

With competitors:

Mr. Kirschbaum referred to this case as "the extreme case" and cited DSM's activities with the American chemical company and competitor DuPont as an example. Here, an area of complementarity was found between the two companies, namely that of advanced surgical biomedical materials, and a joint venture was established for the development, manufacturing, and commercialization of next-generation materials. According to the documentation on the joint venture, ActaMax Surgical Materials LLC, "The early technology development was completed using DuPont materials science and biotechnology capabilities. Commercialization will rely on the medical polymer processing and manufacturing capabilities of DSM." The joint venture does also include collaborative innovation that Mr. Kirschbaum described as belonging to DSM's EBAs. When asked about the complexity of this mode of collaboration, he cited cultural challenges related to the more central role of the

legal department in American corporations when compared to their European counterparts, and where corporate lawyers have a more supportive function. Moreover, he pointed to the fact that collaboration between DSM and a competitor attracts the attention of some regulating authorities such as European Union agencies whose responsibility is to enforce antitrust laws and whose concern when competitors collaborate is the possibility of price-fixing. In this sense, collaborative innovation with a competitor does involve more legal issues relative to collaboration with other actors.

With complementors:

Mr. Kirschbaum identified DSM's collaboration with Bühler Holding AG as an example of collaborative innovation with a complementor. Here the two partners established a joint venture where DSM's knowledge in nutrient formulation and Bühler's capabilities in grain processing were combined to enter a new market for DSM, that of East Asia, with a new product, NutriRice. This collaboration, however, is not an emerging business area for DSM.

Open Innovation across industry (outside of the value net):

DSM's Emerging Business Areas require the company to build bridges to companies from distant industries in order to gain the knowledge which the DSM needs to enter these new markets or to develop completely new products. As a result, the EBAs have led to many open innovation activities between DSM and companies from distant industries. For example, after embarking on a strategy to enter the Bio-based Products and Services Emerging Business Area, DSM established a joint venture with POET, a bio-ethanol producer in the United States market. Prior to identifying this business area as of interest to DSM, its value net did not include players in the business area of advanced biofuels such as POET. Therefore, it was embarking on a corporate-level strategy of industrial diversification into advanced biofuels that led DSM to establish this collaborative innovation venture with a company from a distant industry. An engagement with Roquette, a starch derivatives company, is also an example of a distant company with which DSM is pursuing innovation in the same emerging business area. Concerning the complexity involved when dealing with distant companies, Mr. Kirschbaum cited lower risks, mainly ones associated with environmental factors, such as differences in government policies of companies from different countries.

Conclusion:

Open innovation at DSM is utilized to implement the company's corporate-level strategy that governs what businesses DSM is to be active in. Consequently, DSM attaches great

significance to open innovation, creating a dedicated central management body headed by a VP who reports directly to the company's CEO. Since it is directed at strategic emerging business areas, open innovation at DSM is not strongly attached to the existing and current business function. This allows for greater freedom in pursuing early-stage and potential break-through ideas. In attempting to classify DSM's Open Innovation activities inside its value net, we found the most relevant actors to be technology suppliers (universities and research institutions), and to a lesser extent complementors and competitors. No open innovation instances were found involving end users and or market suppliers. In contrasting value net open innovation with that involving cross-industry and distant partners we found the earlier to be less actively pursued in DSM's EBAs. Indeed, this case study hints that an open innovation strategy aimed at diversification into new business areas would lead firms to partnering with distant partners, outside their value nets, which is the most significant form of open innovation at DSM since embarking on developing the company's competences in an EBA typically requires cross-industry cooperation. We also find that these partners are better suited for the pursuit of radical innovations. An example of this is the collaboration with POET by which DSM is entering the Emerging Business Area of Bio-based Products and Services.

Nevertheless, we find the type of partners involved in DSM's open innovation activities to be an unintended consequence of other factors and not the result of a consciously pursued process of partner selection. Here we can cite the aforementioned example of ActaMax, the joint innovation effort in an EBA between DSM and a competitor. In this case, the engagement was possible due to finding an area of complementarity between the partners that is characterized by high technological uncertainty. This high uncertainty, we suspect, reduced the perceived complexities and made collaborative innovation possible. Thus the type of partner here, being traditionally a competitor, was of less significance due to the degree of innovativeness sought.

4.1.2 Case: Janssen Pharmaceutica

This case study was based partly on documentation describing Janssen Pharmaceutica's Open Innovation activities obtained from the company's website and on my personal interview with Mr. Eric Snoeckx, Director of Open Innovation and Networking at Janssen Pharmaceutica, subsidiary of Johnson & Johnson.

Mr. Snoeckx's office is located at the Janssen Campus Office, which serves as Janssen Pharmaceutica's gate to the external world and its point of contact. Here Mr. Snoeckx's responsibilities include scouting for promising distant ideas and building bridges between the

pharmaceutical industry and various other industries, all with the aim of identifying potential break-through answers to today's most challenging therapeutic questions. He hence works to build and expand Janssen's network in order to discover potential solutions for the long-term and strategic innovation objectives of his company. Janssen Pharmaceutica's open innovation strategy is focused on its goals of the next five to ten years. In our opinion, this strategic application of the innovation paradigm has significant consequences on the nature of the company's dealings with potential innovation partners. Namely, Mr. Snoeckx reaches out to companies for collaboration on early and pre-competitive projects, where the perceived risks and complexities are low. This also explains why the director saw little difference in approaching the various types of partners investigated in this study for open innovation. He stressed that in the early stages of innovation, the type of partner is not a factor that significantly influences the nature of the partnerships. Following his view, open innovation in pre-competitive, front-end stages with a supplier, for instance, cannot be differentiated in terms of the degree of innovativeness sought, the value chain stages where this collaboration is usually conducted, or any particular complexities and risks, with open innovation pursued with a competitor. This can be concluded from the Director's account of his dealings with the different types of actors investigated in this study, which are described below.

Open innovation with value net partners:

Janssen Pharmaceutica develops medicines in five core areas of interest: Cardiovascular and metabolic disorders, Immunology, Infectious diseases and vaccines, Neuroscience, and Oncology. In those areas the company's customers are physicians whom pharmaceutical companies typically approach to market their products. Its competitors consist of other pharmaceuticals active in similar business areas such as AstraZeneca through its subsidiary MedImmune. Market suppliers include the company's employees as well as suppliers of lab materials and raw chemicals. While technology suppliers include universities and research institutions. Since our study is concerned with open innovation at Janssen, which is stationed and pursued at the company's Campus Office, we also add to the value net shown below (in italics) those actors who are associated exclusively with the activities of the Campus Office. The office's value offering from its collaborative innovation agreements is provided to the various and independent business functions operating on campus. In this sense, those functions are the customers of the Campus Office. But they also play a complementary role; the higher the value they offer Janssen's customers, the more appealing the company appears as a partner in innovation and so the higher the value the Campus Office can offer in return.

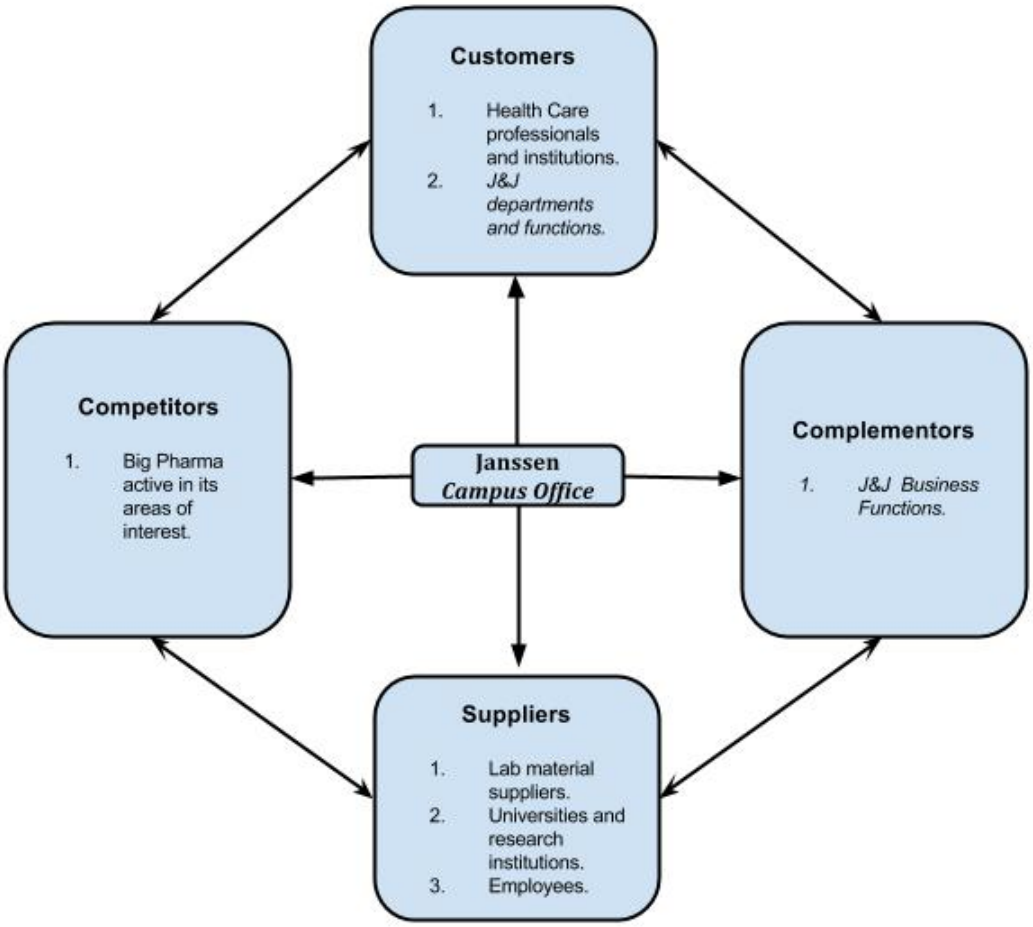

Figure 6. Janssen's value net (actors in italics apply to the Campus Office in particular)
Source: Own projection (adapted from Nalebuff and Brandenburger (1996))

Janssen Pharmaceutica's market suppliers are mainly lab suppliers with whom little collaborative innovation is desired. However when collaboration with them does takes place, it is directed towards strategic innovation. Referring to suppliers, Mr. Snoeckx stated:

> "I am not interested in what [suppliers] currently have on the market or what they are currently doing for us or delivering to us, I am interested however in their strategic agenda."

He stressed the difference between approaching the supplier for strategic innovation as opposed to approaching them for short-term interactions or improvements to existing products and which he described as responsibilities of other departments. This dichotomy in the ways radical and incremental innovation are pursued is important to our investigation in that it hints at a potential significant dimension in differentiating Open Innovation practices, namely that of the degree of innovativeness sought. In this case, Janssen Pharmaceutica

positions its strategic Open Innovation activities at its Campus Office, while incremental innovation in existing businesses is pursued elsewhere, following different innovation processes and managed by different bodies within Janssen.

When asked to reflect on the effect of existing ties between his company and a supplier on an Open Innovation agreement, Mr. Snoeckx attached little significance to this issue. Instead he likened his dealings with suppliers to any other type of partner, being from industry or academia. He attributed this as well to the level of innovativeness pursued, explaining that in dealing with suppliers, he deals with a different level of management at their company comparing to the level that the purchasing department deals with. It is for this reason that the director saw no difference between his dealings among different partner-types nor did he see a one-to-one link between value chain stages and certain types of partners with whom collaborative innovation is sought, although he acknowledged that some partner-types might be more common in certain stages. For instance, he described collaborative innovation with competitors as “pre-competitive work” and associated it more with the early stages of development.

Universities and research institutions play an important role in the value net of pharmaceutical companies as suppliers of knowledge, technology, patents, and scientists. These actors pursue research in areas that are similar to the ones pursued by industry and since they are publicly funded, they are not hampered by the prospect of little or no profit that are sometimes associated with early stages of research. To stay tuned with their work, Janssen Pharmaceutica has established numerous contacts with universities and research institutions on a global level. But these types of engagements between pharmaceuticals and academia have been taking place for decades, are they any different in the context of Open Innovation? On this issue, Mr. Snoeckx described the older way of collaborating with universities whereby companies would pay a university to conduct research in a certain area while maintaining control and ownership of the results, and then he contrasted this to the way the Campus Office collaborates with universities nowadays; instead of specifying narrow research projects, universities are now being engaged by identifying common domains where collaborative research is sought in the next 3 to 5 years. The collaboration takes place on a higher level and is mostly directed towards unexplored and challenging areas. Mr. Snoeckx used early diagnostics for Alzheimer’s disease as an example of this engagement.

Open innovation outside the value net:

The majority of Janssen's open innovation activities with industry partners fall under this category. The Campus Office is looking in directions that are never explored by the company's business functions and this more often than not leads into industries distant to Janssen's own. Connecting to these distant actors, Mr. Snoeckx argues, creates value for Janssen's functions by combining different knowledge and expertise into complete and novel solutions. An example of this is Janssen's collaboration with Intel which aimed to develop capabilities in supercomputing to improve the current limiting speed of computing in DNA sequencing.

Complexity:

Generally, Mr. Snoeckx did not perceive dealings with specific partner types as being more complex than others, nor did he see a significant difference in complexity between value net partners or otherwise. This we attribute to what was described previously as the pre-competitive and long-term orientation of Janssen's utilization of open innovation. He did however point to firm size as affecting the complexities associated with collaboration. Smaller firms and universities are less complex to deal with when compared to large companies.

Risk:

Mr. Snoeckx saw little risk in dealing with open innovation partners. He stressed the importance of establishing trust with the partner, an initial step in the process and requiring nine to twelve months. During this stage no sensitive information is exchanged and therefore there is little risk of a knowledge spillover, and the type of partner involved is not a factor significantly affecting risk even when dealing with the competition, he stressed.

Incremental vs. radical innovation:

Regarding a correlation between certain types of partners and the degree of innovativeness, Mr. Snoeckx saw collaborating with distant partners as offering a higher chance for disruptive innovation relative to collaboration with closer actors, such as competitors.

Conclusion:

Janssen Pharmaceutica's application of open innovation is similar to that of other large companies in that it is exploratory in nature and directed towards areas of high uncertainty and low perceived risk. Janssen physically separates the location where Open Innovation is managed from its existing and more conventional lines of business. Here, Open Innovation is the responsibility of the Campus Office, which is informed about the middle- and long-term

objectives of the company's business functions and uses an open approach to identify and develop promising solutions to these strategic challenges, creating value in return for the business functions and helping them reach their objectives.

With regards to its dealings with open innovation partners, Janssen does not attach a priority to any particular type of partner. Indeed, in the strategic and long-term context of its utilization of Open Innovation, partners within as well as without its value net are equally considered as potential partners in innovation, although the majority of the Janssen's open innovation partners happen to be other companies from distant industries. Moreover, Janssen has innovation agreements with many universities on a global level. These agreements are increasingly taking the shape of more general frameworks for collaboration bent on tackling complex challenges.

In conclusion, this case study demonstrates some features of long-term and strategic open innovation, hinting that the pursuit of open innovation for incremental innovation or innovation that includes a commercialization aspect in sight is significantly different from open innovation when pursued in early and pre-competitive stages.

4.1.3 Case: SCK•CEN (Studiecentrum voor Kernenergie•Centre d'Étude de l'énergie Nucléaire)

This case study was based mainly on my personal interview with Mr. Dirk Ceuterick, Deputy Director of Business Development & Support at the Belgian Nuclear Research Center (SCK•CEN).

SCK•CEN was chosen as a case study in my research because of the company's unique multiple roles as traditionally a research institution in the domain of nuclear science, but also as a supplier of certain radioisotopes on a global level, and moreover, as a service provider offering radiation treatment of some materials used in the electronics industry. Hence the institute can offer an insight into collaborative innovation partnerships on three fronts, involving itself as a market supplier with industrial customers, but also as a technology supplier with these customers, and finally between itself as a research institutions with similar institutions. SCK•CEN receives half of its funding as an annual endowment by the Belgian government while raising the other half is the responsibility of the institute. This creates a situation where it is increasingly seeking options for the commercialization of its knowledge, products, and services. Consequently, and under pressure of the need to raise additional funds, the institute has embarked on a strategy of increasing the valorization of its internal research as well as profits from its other activities. This task is a form of outbound

open innovation involving the development of the ability to identify research directions with high potential for legal protection and valorization at an early stage, and then allowing this research to exit the boundaries of the institution and into industry in exchange for royalties or licensing fees. The strategy also requires establishing more industry connections in order to gain market access and knowledge which, being a research institution, SCK•CEN does not possess internally. Both tasks are the responsibility of the Business Development & Support unit of which Mr. Ceuterick is Deputy Director.

Open Innovation within its value net:

As mainly a research institute SCK•CEN customers include companies from industry who pay for contractual research. Also a customer is the Belgian government, which provides half of the institute's annual funds. As a service provider the customers would also include firms paying the institute for its radiation services. Other research institutions play both competitive and complementary roles in the value net of SCK•CEN since they can offer substitute research but also increase the value of the institute's research by advancing the field of nuclear energy and other complementary research directions.

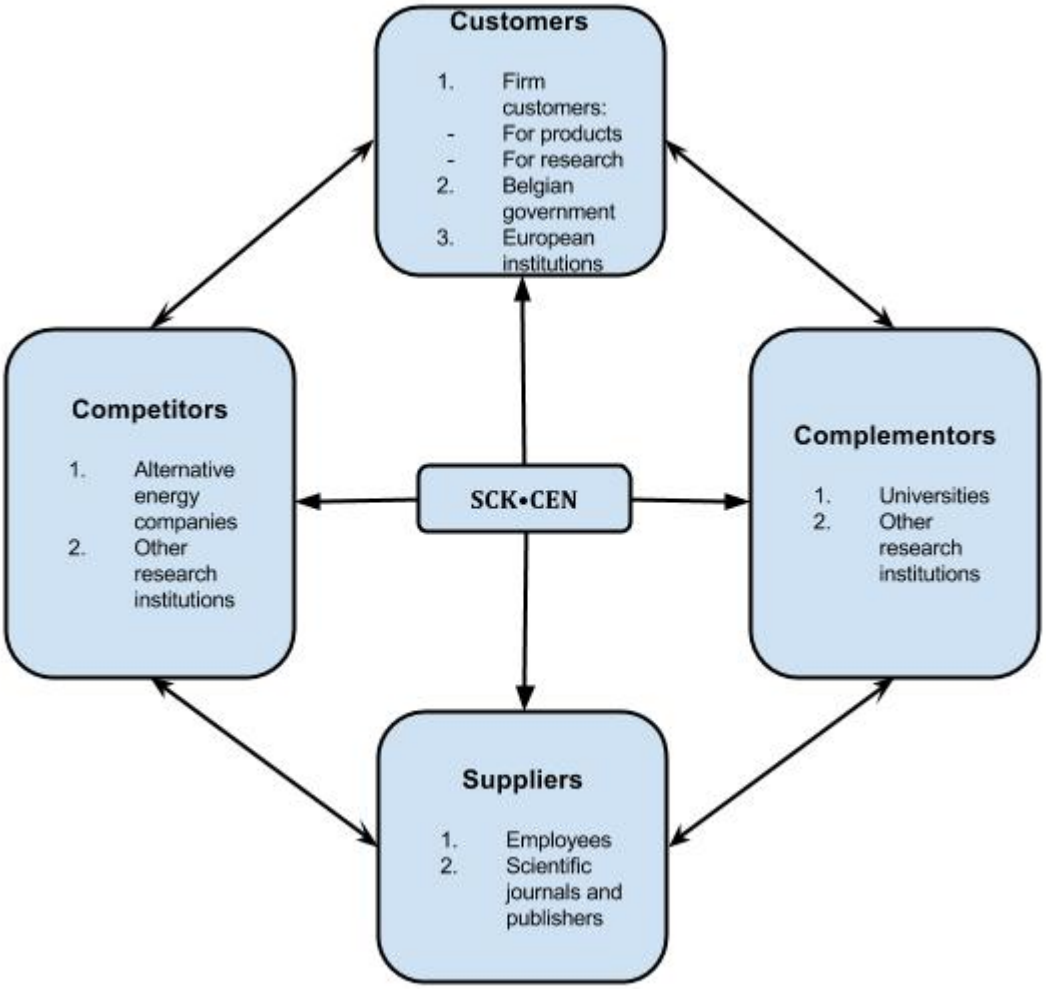

Figure 7. SCK•CEN's value net
Source: Own projection (adapted from Nalebuff and Brandenburger (1996))

The majority of its collaborative innovation activities fall under this category as European institutions, such as the European Commission and EuraTom are funding open innovation projects in the field of nuclear energy. Moreover, prominent energy companies are funding research consortiums in this field, with the result being that research institutions are increasingly working together, and in some cases on several projects simultaneously. The following sections will cover the company's open or collaborative innovation activities, which we will separate depending on the role SCK•CEN played being a market or a technology supplier.

As a market supplier:

SCK•CEN is an important supplier of certain nuclear isotopes. When asked about collaborative innovation between his company and customer firms Mr. Ceuterick shed some light on the complexities involved. A multinational chemical company had shown interest in SCK•CEN's product offering and proposed an agreement where the center would supply the larger company with a certain isotope. Mr. Ceuterick described how his company wanted to establish a partnership with the chemical buyer, which would include engagements on more fronts than manufacturing, but the larger company resisted this. He explained:

> "We are in negotiations with a large chemical company and the point there is that they see us more as pure supplier of this radioisotope than a partner, while we are aiming to set up a kind of a partnership. We need to find partnerships with companies that are more than buyer-supplier relationships."

This experience highlights the difficulties involved in establishing open innovation efforts between buyers and their market suppliers. Mr. Ceuterick also sees firm size to affect the level of complexity associated with collaborating with a customer. He cited a collaboration that began between SCK•CEN and a small Scandinavian pharmaceutical firm of about 50 employees. During the negotiations the pharmaceutical firm was bought by a chemical multinational company and the negotiations between the managements of the companies were significantly relative to the ones with the smaller firm.

As a research institution:

Innovating with other research institutions is a usual practice at SCK•CEN. This collaboration, can be sponsored by governmental institutions or by companies from industry. A significant differentiating factor between research done in this context and that done in

collaboration with industry lies in the often absence of a strategy for the commercialization of research. Mr. Ceuterick explained, “Sometimes you see that a certain research project has been going on for 10 to 20 years and may not necessarily have a clear means for valorization.” Reflecting on the complexity in this context, Mr. Ceuterick pointed out that when the number of research partners is large, involving in some cases 10 to 20 research partners, a significant management challenge arises since in those cases, there is a difficulty in protecting research results and little clarity regarding how these results will be treated by the other partners involved.

Open Innovation outside its value net:

Here the director recounted the accidental discovery of a cholesterol-lowering effect of an algae strain, and which initially had been investigated for its resistance to radiation in a space environment. But as this unexpected application was not related to SCK•CEN’s domain of nuclear science, and requiring technological and market competences for its further development and commercialization and which the institute lacks, a partnership with a company from that industry is necessary. Here, a Dutch firm from the food additives industry showed interest and an agreement was made between the two companies for further development and commercialization. SCK•CEN therefore utilized an inside-out process of open innovation in order to commercially benefit from internal research. Nonetheless, we find it important to note that the center did not actively pursue this opportunity. Instead, it was the management of the Dutch firm who approached the center with interest in this research. This example highlights a self-confessed difficulty of identifying promising internal research and if the case is made for a spinoff, of selecting suitable partners from industry for cooperative development.

Incremental vs. radical innovation:

Considering the nature of research in the nuclear field, innovation at SCK•CEN is mainly incremental, although when radical or distant discoveries are found, they are spun-off in external incubators. Like the joint venture in food additives, DoseView is a spinoff company of SCK•CEN that was established when a potentially profitable technology was developed in the institute’s labs. Mr. Ceuterick explained that this is characteristic of their operation as a research institute whose source of funding is, at least in part, public. “We are a public utility and it is not our ambition to set up commercial activities. But what we can do of course is participate in spinoffs and set up joint ventures with other companies. But we will never commercialize on a high level under our own name.” This was the approach SCK•CEN adopted with the aforementioned spinoff, DoseView. When the promising technology was

identified, SCK•CEN sought opportunities to externalize it by jointly developing the technology in a joint venture with other industry partners.

Conclusion:

SCK•CEN is a research institution specializing in the field of nuclear energy. Only partly funded publicly, it is under growing pressure to increase profits from its own activities, which include contractual research, providing radiation services, and producing certain radioisotopes for industrial applications. Financial pressures are thus driving SCK•CEN to increase its collaborations with external parties as well as to better exploit its own internal research. The value net of the institution includes actors familiar to it, such as government and other research institutions, energy companies, and the scientific community. Most of the center's collaborations with external partners and more specifically its collaborative research activities take place within its value net. However, a few examples were found where the center collaborated with industry partners from distant industries. We found that in its value net, SCK•CEN pursues innovation that fits within its knowledge domain of nuclear energy. This is mostly of the incremental type. When it identifies a promising line of research not directly related to its own, SCK•CEN seeks to externalize this by establishing joint ventures with partners from industry. This implies a greater association of incremental innovation with value net partners of SCK•CEN while more radical innovations are associated with actors outside this value net.

With regards to the complexity involved in its collaborative innovation efforts, the Deputy Director saw firm size as affecting the level of complexity involved when dealing with industry partners. Larger firms are more difficult to deal with than smaller firms. When partnering with similar research institution the Director found some management challenges such as in the protection of research results, especially when the research involves a large number of partners.

4.1.4 Case: AstraZeneca

This case study was based on data collected through a study of the documentation on AstraZeneca's open innovation program as well as my interview with Dr. Peter Simpson, Director of Screening Sciences and Compound Management at AstraZeneca.

Introduction:

AstraZeneca is a multinational pharmaceutical company active in the development, manufacturing, and commercialization of medicines in the three core activity areas: Cardiovascular and Metabolic disease, Oncology, and Respiratory, Inflammation and

Autoimmunity. Open innovation at AstraZeneca is mainly pursued using a recently introduced web-based open innovation platform with which the company aims to access a valuable knowledge pool of scientists and researchers in academia and smaller organizations. Dr. Simpson was a member of a team of five scientists at AstraZeneca who set up the web portal and who later formed a steering committee to manage the portal's activities.

Motivating external scientists to use this platform is their need to access resources that are only available at larger organizations specialized in their fields. Here a win-win situation is possible whereby they can submit research proposals in areas of interest to AstraZeneca and in case the company sees promise in their research the scientists are granted access to its bank of chemical compounds and testing facilities, meanwhile the company benefits by learning about new research trends and more importantly, by creating an option for a future partnership with the scientist to further develop any potentially profitable idea. Even though this open innovation web portal is not exclusive to any particular type of partner, the majority of its participants happen to be scientists from academia. We found this prevalence of this type of actor unsurprising given the nature of the portal, which I will describe in the value net section of this case, and AstraZeneca's philosophy of open innovation, which the Director summed up as:

> "We do not know what we do not know. We do not know who else would have a solution or an idea or an insight. So for us Open Innovation is not directed towards particularly famous people, it is instead available to anybody with a bright idea that we may have not come across otherwise."

AstraZeneca, therefore, pursues an inbound open innovation process that is not intentionally directed towards particular actor types. As for partnering with companies familiar to AstraZeneca from industry, this takes place according to more conventional partnership models, which the Director distanced from open innovation, citing his view of the innovation paradigm as best fitting speculative areas where uncertainty and risk are high but also where financial profits can be anticipated.

Open Innovation within its value net:

AstraZeneca's value net is shaped by the nature of the company's industry and by environmental factors, such as the health care policies of the countries where it operates.

Being a pharmaceutical firm, its customers include the government, pharmacies, and large buyers of generic medicines. Its competitors include similar large pharmaceutical companies. Its complementors include physicians, who play an important role when prescribing the company's medications to their patients, and insurance companies, which can influence the value of AstraZeneca's offerings with their coverage policies. AstraZeneca's suppliers include lab material suppliers, who provide the company with raw chemicals and tools, and more importantly, they include scientists from academia and research institutions, who supply pharmaceutical companies with knowledge, patents, and human capital.

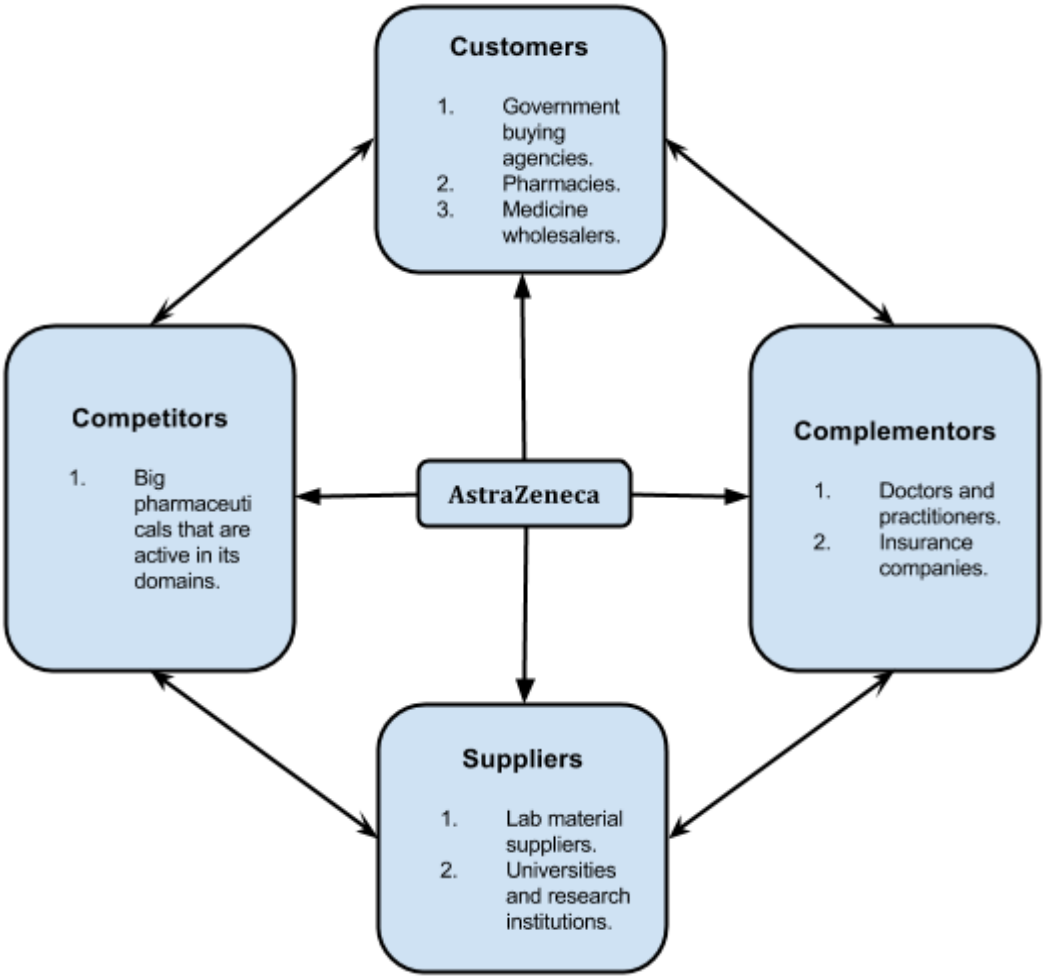

Figure 8. AstraZeneca's value net
Source: Own projection (adapted from Nalebuff and Brandenburger (1996))

AstraZeneca's open innovation activities fall under this category, this is according to the company's understanding of the innovation paradigm and which separates its more conventional collaborative innovation partnerships and alliances from its open innovation activities. Nevertheless, the earlier does take place within the company's value net where it has many innovation-focused partnerships with other pharmaceutical companies, including

some of its competitors, such as Bayer AG. The interviewed director distanced these collaborations from the concept of open innovation, citing the legal procedures involved and narrowly defined domain of partnership, which in his opinion does not characterize the speculative and more loosely defined activities in open innovation. Other examples of these engagements include AstraZeneca's funding of the research and development of Tenapanor, a drug by Ardelyx. In Oncology AstraZeneca is investing in a Chinese firm currently developing a promising medicine for tumor-growth inhibition. The deal includes a licensing component that will enable AstraZeneca to participate in the development of the drug as well as grant it rights to commercialize the drug outside the Chinese market. It is noteworthy however to point to the fact that the Director did not label these activities between AstraZeneca and these partners as open innovation.

What AstraZeneca understands as open innovation it pursues via its web portal where it receives project proposals from external sources, mainly being scientists from academia, and whom we categorized as technology suppliers. Using this web portal, AstraZeneca seeks external ideas in its five areas of core activity, which are Cardiovascular and Metabolic Disease, Respiratory, Inflammation, and AutoImmune, Oncology, Infection, and Neuroscience. In each of these five areas, submissions from external scientists are possible. In order to achieve a better structure and results that are more relevant the company further divides the participation within each of the areas into several modules depending on their stage in the innovation process. These modules are New Molecule Profiling, Target innovation, Pharmacology Toolbox, and Clinical Compound Bank. These modules, along with the structure of the web portal are shown below:

Figure 9. AstraZeneca's open innovation web portal
Source: adapted from the company's website

The majority of participants are academics, albeit depending on the module, certain disciplines are more relevant. For example, in New Molecule Profiling these are typically chemists, while in Target Innovation they are biologists, and in the Clinical Compound Bank module they are clinical investigators. When asked to reflect on the prevalence of academics as participants, the director attributed this to AstraZeneca's understanding of open innovation as offering a learning opportunity that does not involve the purchasing of intellectual property or complex legal agreements that are typically associated with industry partners. These latter engagements are pursued under more conventional partnering agreements and which he does not consider as applications of open innovation.

Complexity:

The web platform described earlier constitutes AstraZeneca's official utilization of Open Innovation allowing scientists to submit research proposals that are then screened by AstraZeneca and chosen for further development if found of interest to the company. The engagement between the company and scientists on this web platform is well defined and allows AstraZeneca flexibility to choose the level of its involvement in the projects. When a proposal is selected it proceeds in the following stages of development under AstraZeneca's supervision and if it proves to be useful for the company's business the scientist is then offered to share their results with AstraZeneca while maintaining ownership of their intellectual property. Hence we find this facet of Open Innovation at AstraZeneca to involve a low level of complexity. As for managerial aspects, the management of the web portal is divided among five scientists at AstraZeneca, whereby each scientist is responsible for a module of the platform. Together, the scientists form a steering committee that manages the overall strategy of the portal.

Radical vs. Incremental innovation:

The knowledge, which AstraZeneca is seeking with its open innovation activities, is similar to its own. This leads us to consider these engagements as aimed towards incremental innovations due to knowledge similarity and the fact that AstraZeneca limits the domains where open innovation is pursued to ones the company is currently active in and familiar with.

Conclusion:

AstraZeneca distinguishes between its more traditional innovation-focused partnerships and its more recently introduced open innovation activities. The earlier partnerships take place mostly with value net partners such as complementors and competitors. And even though these agreements do involve in-licensing and out-licensing as well as joint research and

development among the partners, they do not fit the company's understanding of Open Innovation and hence they are pursued separately and not labeled as such. This is also an example of the variation in the way Open Innovation is understood and adopted by large companies. In this case, the Director perceives Open Innovation as a more speculative phenomenon, win-win collaboration, and one where the legal department has little involvement. AstraZeneca's industrial collaborative innovation activities involve a higher degree of complexity and are managed on a higher level relative to the company's open innovation platform.

AstraZeneca's Open Innovation strategy employs a web portal targeted at scientists and researchers that are outside the company's value net. The type of participants here, being value net actors (technology suppliers) typically from academia, is less intentional and more of a consequence of the way the web portal is designed to function. Namely, the web portal allows external participants submitting research proposals to request access to AstraZeneca's bank of compounds and other company facilities that are not easily available elsewhere. In exchange, the portal offers AstraZeneca access to new ideas and emerging lines of research that may otherwise have been overlooked by the company. The engagement is well defined and restricted to the five core domain where the company is active. This fact, in addition to not looking into distant industries makes us conclude that the company's strategy of Open Innovation is on a business level. This is also evident from the fact that the initial adoption of open innovation and thereafter the management of its activities are not part of the company's corporate strategy. Another consequence of this we believe is the limiting of innovation outcomes to incremental innovations since more disruptive innovation requires commitment and willingness of corporate management to explore solutions which may not fit the current activities of the firm.

This case study points to the lower complexity associated in dealing with scientists from academia in comparison with industry partners. The way AstraZeneca pursues Open Innovation by seeking external research proposals in its own domains of activity leads to a collaborative innovation that is low in uncertainty, not taxing on its resources, and not requiring lengthy legal agreements, which is partly due to the power balance between AstraZeneca and the individual partners being strongly in the company's favor.

4.2 Cross-case assessment

Based on data from our case studies, the following table was compiled to show characteristics of open innovation at the companies investigated that are relevant to our study.

		Case I: DSM	**Case II: Janssen Pharmaceutica**	**Case III: SCKCEN**	**Case IV: AstraZeneca**
Open innovation activities		Inbound	Inbound	Inbound and outbound	Inbound
Open innovation management		Centralized with dedicated functions	Centralized with dedicated functions	No dedicated functions for OI. Responsibility of the business development team	Decentralized. Responsibility of five scientist employees at the company
Partners in open innovation					
	Value net partners	Competitors, technology suppliers, complementors	Competitors, technology suppliers, complementors	Competitors, technology suppliers	Technology suppliers
	Non-value net partners	Cross-industry companies	Cross-industry companies	Cross-industry companies	None
Open innovation objectives		Entering emerging and promising business areas with break-through technology	Developing break-through innovations in current business areas	Growth in existing business areas and valorization of profitable research in distant business areas	Access to innovative research in current business areas
Degree of		Disruptive	Disruptive	Incremental	Incremental

innovativeness sought				(inbound) and radical (outbound)	
Perceived complexity in value net open innovation		Moderate	Low	Moderate to high	Moderate
Perceived complexity in open innovation without value net		Low	Low	Low	n/a
Perceived risk with value net partners		Moderate	Low	Moderate	Low
Perceived risk with non-value net partners		Moderate, mostly environmental risks such political policy fluctuations and legal regulations	Low	Low	n/a

Table 6. Cross-case overview

Chapter 5 - Discussion and conclusion

5.1 Theoretical contribution

This study attempted to explore the types of partners companies involve in their open innovation activities. We based our differentiation of partner types on the concept of the value net of companies, therefore identifying two main categories of partners, value net and non-value net ones. Value net partners include suppliers, customers, competitors, and complementors while non-value net partners are more distant actors whose offering did not influence that of the firms investigated. We proceeded with analyzing how four companies conduct their open innovation activities relative to their market and technology value networks, while keeping in mind an objective of exploring a plausible basis of classification of their activities. This goal is one which some researchers have attempted previously albeit with different criteria of classification. They have nonetheless attached great importance to this effort, some arguing that it is necessary for the conceptual development of the open innovation paradigm. In the following sections we conclude with propositions drawn from the data we gathered in the course of our investigation.

Classification of open innovation practices

Our results testify to the wide variation in the ways firms understand and apply the open innovation paradigm, even among the managements of large multinational corporations operating in similar industries. When investigating the types of partners they involve in open innovation relative to their value nets, DSM involved firms from distant industries which at the time were far from its value net, while Janssen Pharmaceutica involved both value net as well as non-value net actors in open innovation, this is also the case with SCK•CEN, which pursued its inbound and coupled open innovation processes with value net partners but outbound open innovation with actors from distant industries. AstraZeneca kept its open innovation activities within its value net. In the table below we expand each of our two categories to include their subtypes which we studied in our investigation. The value net thus includes suppliers, customers, competitors, and complementors; non-value net partners are cross-industry companies who did not play a complementary role to the four firms we studied. The results are as follows:

		DSM's EBAs	Janssen	SCK•CEN	AstraZeneca
Value-net partners	**Suppliers**	●	●	●	●
	Customers	n/a (not active in end markets)	○	n/a (not active in end markets)	○
	Competitors	◑	◑	○	○
	Complementors	◑	◑	○	○
Non-value net	**Distant industries (non-complementary)**	●	●	◑	○

Table 7. Analysis of partners involved in open innovation

○: not pursued

◑: not strategically pursued but practiced when needed

●: strategically pursued

While our results do indicate a prevalence of suppliers as open innovation partners, it is important to note that we are including universities under the supplier category. Although universities are not market suppliers, they act as suppliers in the sense that they supply the investigated companies with knowledge, personnel, and patents. All of which increases the value of the companies' offerings. If we considered only industrial suppliers in our study, our results would be quite different. In fact, none of the firms investigated collaborated with its industrial suppliers on innovation. Consequently, our results point to the difficulties involved in close collaboration with **industrial suppliers** on innovation, which is consistent with our expectations based on our review of the existing research on the topic. Collaborative innovation with **technology suppliers**, such as universities, on the other hand, is relevant and strategically pursued by the companies investigated, which is also consistent with our expectations of the lower complexity and risk in dealing with universities. On open innovation with **customers**, we limited our study to investigating end users, excluding industrial buyers. As a result two of our case studies, DSM and SCK•CEN, do not offer applicable results as

they are industrial players who are not active in end markets. The two remaining cases of Janssen Pharmaceutica and AstraZeneca are both pharmaceutical companies who did not innovate with end users. We suspect this to be a consequence of the nature of their industry, which is also consistent with our review of existing research suggesting that open innovation with end users is relevant only in some industries and not others. Our results suggest that the pharmaceutical industry is not one of these industries were open innovation with the end user is of interest to companies. As for **competitors,** DSM was found to pursue open innovation with a competitor in one of its EBAs, but this is an "extreme case" as the director of open innovation at the company described it. At Janssen, no examples were found of open innovation with competitors, but the director interviewed indicated that as his company pursued open innovation in early and pre-competitive stages, collaboration with a competitor is possible. The two remaining cases, SCK•CEN and AstraZeneca did not innovate jointly with their competition. These results were expected considering the complexities involved in dealing with the competition, especially considering these companies' focus on incremental innovations. Alas, both the DSM and Janssen cases may point to a decreased significance of the perceived complexities associated with innovating with a competitor in the case of early and pre-competitive projects. I will discuss the possible effect of the degree of innovativeness sought on partner types in a separate section of my findings. Regarding **complementors**, none of the companies investigated had a strategy of seeking complementary partners for joint innovation. However, examples were found of projects of this type at DSM (not in an EBA), and Janssen Pharmaceutica with a high-tech company.

Open innovation **outside the value net** was prevalent in the cases of DSM and Janssen Pharmaceutica but not so much in the cases of SCK•CEN, which pursued only outbound open innovation with distant partners, and that of AstraZeneca, which did not actively engage distant partners in innovation. We attribute the interest in engaging distant partners in innovation and the lack thereof to the different degrees of innovativeness sought by the investigated companies, which I will discuss in a separate section.

Based on our results, we conclude with the following propositions:

- **Both value net and non-value net partners appeared relevant in our results. However, if consideration is given to whether partners were market or technology partner, we found market partners the least relevant.**

- **Partner selection is not a systemic process in open innovation. Companies do not deliberately seek particular partner-types for open innovation. Instead, we**

propose that the prevalence of some partner-types is an unintended consequence of other mediating factors.

- **We identify these factors which may prove solid basis for differentiating open innovation practices. Namely:**
    1. **The level of strategy pursued by open innovation, being corporate-level strategy as in the case of DSM or business-level strategies as in the case of Janssen Pharmaceutica.**
    2. **The degree of innovativeness sought to achieve by open innovation, being radical innovation as in the cases of DSM and Janssen Pharmaceutica, or incremental innovation as in the cases of SCK•CEN and AstraZeneca.**

The following sections will more thoroughly explore each of these two factors of differentiation.

Business strategy and partners in open innovation

Our study further emphasizes the crucial function of strategy in open innovation. Explicit corporate and business strategies, a centralized strategic direction to pursue open innovation or the lack thereof, a clear understanding of the open innovation paradigm and the gains expected from adopting it, all crucial factors which shaped open innovation strategies of the companies investigated. Our research hence underlines the scholarly calls for expanding the current perception of open innovation to include and start with business strategy (Chesbrough, 2007; Lichtenthaler, 2011; Vanhaverbeke, 2013; Wagner and Piller, n.d.).

In the course of my investigation I covered the case of DSM where open innovation was adopted to pursue radical innovations, implementing the company's corporate-level strategy of entering emerging business areas with break-through technology. I also covered the case of Janssen Pharmaceutica, where open innovation is also utilized to pursue radical and strategic innovations but with the aim of providing Janssen's various business functions with better competitive positions in the long run within theirs domains. In terms of strategy, we find that Janssen's application of open innovation is on business level since unlike DSM, Janssen is not seeking a departure from its existing businesses to completely new business areas, and instead it uses open innovation to pursue breakthrough innovations in its current therapeutic domains. This is consistent with our understanding of corporate-level strategy as

answering the question: "What business are we in?"[1] And business-level strategy as answering: "How do we compete?"[2] Like Janssen, AstraZeneca is a case where open innovation is utilized to implement the business-level strategies of the company, but unlike Janssen, the aim is not to introduce radically new products. Instead the company seeks novel ideas on applications of existing compounds that may have been overlooked by the company's scientists. In the case of SCK•CEN we find yet another application of open innovation. Here the company seeks to externalize its own research using spin-off companies and joint ventures as a strategic direction to increase revenue by finding cross-industry applications of the center's research. But due to the nature of SCK•CEN, being partly a publicly-funded research institute, it has restrains on the types of businesses it can pursue on its own. So when certain internal research has potential for valorization but is distant to the institute's main focus on nuclear science, this research is externalized in collaboration with industry partners, and who typically belong to business areas distant to that of the institute. Since SCK•CEN is seeking open innovation solution as an implementation of a corporate-level strategic direction to valorize its internal research by seeking a form of outbound open innovation, we consider this an example of corporate-level open innovation.

Degree of innovativeness sought

In the course of our investigation we observed how the degree of innovativeness sought by firms can be a factor shaping the way they pursue a strategy of open innovation. In particular we observed how DSM and Janssen Pharmaceutica apply open innovation to seek radical and break-through solutions to long-term and strategic challenges. On the other hand we found SCK•CEN (in its inbound and coupled) and AstraZeneca applying open innovation mainly to seek incremental improvements on existing products and services. To reach these goals, the first group's open innovation activities involved mostly distant partners from outside their value nets; for DSM, its strategy of growth in emerging business areas has led the company to establish open innovation partnerships with companies such as POET, a bio-ethanol producer, and Roquette, a starch derivatives company, both in order to advance its Bio-based Products and Services emerging business area. Neither company belonged to the value net of DSM prior to these open innovation engagements. Janssen Pharmaceutica

[1] We adopted the definition of corporate strategy by Andrews & Bower (1978) as "the pattern of major objectives, purposes, or goals and essential policies and plans for achieving those goals stated in such a way as to define what business the company is in or is to be in and the kind of company it is or is to be."

[2] Business strategy focuses on how to compete in a particular industry or product-market segment. Thus, distinctive competences and competitive advantage are usually the most important components of strategy at this level (Hofer and Schendel, 1978).

has open innovation engagements with companies from the artificial intelligence, IT, and telecommunication industries from among others. These industries are distant from Janssen's own as a pharmaceutical company. We hence observe that when these companies are seeking radical innovations they are resorting to partners from distant industries. This is consistent with our study's theoretical background which associates radical solutions with knowledge diversity among the partners involved in collaborative innovation. Therefore, this first group of firms in our study is seeking to create novel combinations from its own knowledge and the knowledge of companies from different backgrounds. With regards to our second group, which includes the cases of SCK•CEN and AstraZeneca, here both companies are seeking incremental innovation. In the case of the earlier, SCK•CEN's partners in its inbound open innovation are ones who belong to its value net; and involving mainly similar institutions as well as energy companies to conduct research on improvements in nuclear sciences. More distant partners were only involved in SCK•CEN's out-licensing deals and the establishment of spin-off companies. In the case of AstraZeneca, the web portal that the company has set up accepts submissions in the domains of the company's business domains. The requirements for these submissions are well defined and hint at the knowledge similarity characteristic of this mode of engagement. Here the partners are expectedly close enough to AstraZeneca to belong to its value net. Namely, they are scientists from academia or independent researchers who all fall under the category of suppliers in AstraZeneca's value net.

Our results therefore show that the companies seeking radical and break-through innovations are doing so by involving distant firms who do not fall in their value nets. Incremental innovation, on the other hand, is more associated with value net partners, suppliers in particular. These results were expected considering the concept of knowledge similarity, and which can limit the outcomes of collaborative innovation within the value net of a firm.

Based on these results we propose the following:

- **The pursuit of radical innovation is more likely to result in open innovation partnerships with distant companies from without the value net of the firm.**

- **The pursuit of incremental innovation is more likely to result in open innovation partnerships with companies from within the value net of the firm.**

Combining the two factors:

Hence we find two major factors at play: (a) the level of strategy open innovation is used to pursue, and (b) the degree of innovativeness sought by the company. Using these two dimensions, we can plot our cases in the following fashion:

Innovativeness / Level of strategy	**Radical innovation**	**Incremental innovation**
Corporate-level OI	DSM	SCK•CEN (outbound)
Business-level OI	Janssen	AstraZeneca SCK•CEN (inbound)

Table 8. Classification framework based on strategy and degree of innovativeness

With regards to the main subject of our study, the type of partners involved in these different applications of open innovation, we find our evidence hinting that this may also be influenced by the two dimensions in the framework above. In the case of DSM's EBAs, open innovation is typically pursued with partners whom, prior to DSM embarking on a strategy to enter their fields of business, were distant to DSM and not actors in its value net. This is an expected consequence of DSM's fusion of its corporate-level strategy and its pursuit of radical innovations. When its corporate strategy eyes an emerging new business area for future growth, it is expected that the partners sought are ones who are distant and not do not belong to DSM's value net. In our second case study, Janssen Pharmaceutica, open innovation is geared towards radical innovations within the company's therapeutic domains. This requires both familiar partners with similar knowledge as well as more distant ones where the diversity of knowledge can foster breakthrough solutions, such as technology companies. We find that in the case of Janssen, both value net partners as well as distant ones are relevant. To quote Janssen's documentation on its own open innovation activities: *"we are not only looking for partners in the traditional pharmaceutical context, we are also looking for collaboration opportunities with companies operating in artificial intelligence, domotics, wireless and mobile communication, IT and logistics."* In SCK•CEN's case, open innovation partners are either companies with whom SCK•CEN has established a spin-off or licensees of its research, or other research centers with whom SCK•CEN is conducting open research in the field of nuclear energy. Setting SCK•CEN apart from the three other case studies is the fact that it seeks outbound open innovation when the research in question is distant to its own. In its outbound activities, partners are mostly distant ones not belonging to its value net. Two examples of this are the spin-off in medical imaging and the joint venture in food additives industry. Both partners in these examples belong to industries distant to

SCK•CEN. Alas, in the company's domain of nuclear sciences, open innovation partners are ones from within its value net, being similar research institutions or energy companies. The fourth case study is that of AstraZeneca, here the company seeks incremental innovations in its existing lines of business by inviting scientists from academia to take advantage of the company's resources by submitting research proposals. By seeking innovative ideas from researchers the company is reaching out to partners from within its value net, but ones that it typically does not approach for collaborative innovation. In the words of the director interviewed: "For us open innovation is not directed towards particularly famous people." The partners sought by AstraZeneca for open innovation, hence, are scientists who normally act as suppliers of research and patents to pharmaceutical companies.

Based on these case studies and using the framework we sketched earlier we can include partner types as follows:

Innovativeness / Level of strategy	**Radical innovation**	**Incremental innovation**
Corporate-level OI	(DSM's EBAs): Partners from distant industries.	(SCK•CEN-outbound): Partners from distant industries.
Business-level OI	(Janssen Pharmaceutica): Partners from within the value net as well as more distant ones.	(AstraZeneca): Value net partners (SCK•CEN-inbound): Value net partners.

Table 9. Classification of partner types in the cases studied

Based on these findings, we propose the following:

- **The higher the level of strategy which open innovation is being utilized to implement the more likely that companies will engage more distant partners in open innovation.**

Complexity and risk

Considering the cases of DSM and Janssen Pharmaceutica, we observed how the directors of open innovation from both companies associated little complexity and risk when describing the activities of open innovation at their respective companies. Indeed, the risks they mentioned in this regard were mostly environmental ones, such as unpredictable governmental policies in renewable energy, an emerging business area for DSM. Moreover, the director of open innovation at Janssen described how remotely relevant business risks

are in the early and pre-competitive stages of the innovation process. He also saw no significant differences in dealing with different partner types in these early stages. This is a quite different perspective in comparison to our results from the two other cases in our investigation, namely those of SCK•CEN and AstraZeneca whose interviewed managers cited increased complexities in their open innovation activities. Thus, SCK•CEN struggled to establish partnerships with its industrial customers that involved more activities than supplying products and services, which is resisted by its customers. AstraZeneca utilized a narrow and well-defined window of partnership in its open innovation web portal. The platform defines the range of engagement, a number of areas of interest to the company and where it sought proposals, and the legal details on the ownership of intellectual property and research and resultant findings. We attribute the increased complexity to the later stages in the innovation process where these open innovation activities are taking place. Hence we propose the following:

- **The more radical and long-term-oriented the innovation sought by the company is, the lower the perceived business complexities and risks. Conversely, seeking incremental innovations in later stages of innovation is associated with higher perceived complexity and risk.**

- **The more radical and long-term-oriented the innovation sought by the company is the less impact the closeness of the partner has on the process of innovation.**

5.2 Managerial implications

Managers should know their value net players

Not only is this beneficial in terms of capturing value from existing operations as the authors of the concept have suggested, but it is also applicable in open innovation. Existing research have indicated that partner from the value nets of companies are the most prevalent source of external knowledge in inbound open innovation. In our case studies we also found evidence of supplier and competitor involvement in open innovation but not of customers, which we attributed to the nature of the industries of the companies investigated. Complementors were not part of the cited background research. This may be due to the fact that in spite of the great influence they can have in increasing the value of a company's offering, they are a lesser-known player type comparing to the others. Our research also points to an associated between open innovation within the value net and incremental innovations. So if managers are looking to improve their competitive position in current

business lines, it is crucial to keep an eye out for innovation partners from within this category.

Managers must shape and articulate a clear strategy for open innovation

Our case studies indicate that companies can benefit from the formulation of an explicit strategy for open innovation. We believe that this strategy should include the following:

1. It states the way the company understands open innovation and the types of activities it aims to pursue being either inbound, coupled, or outbound activities.
2. It describes the goals it aims to accomplish from open innovation, including the degree of innovativeness sought being incremental or radical innovations.
3. It incorporates an explicit link to the company's corporate-, business-, or operational-level strategies, depending on the firm's objectives. This can be done by describing the domains in which open innovation is desired.

The issue of strategy has yet to receive deserved attention in open innovation literature. Managers must not, in any case, interpret this as indicative of the role strategy plays in the application of open innovation. On the contrary, they and employees alike can greatly benefit from an explicit strategy for open innovation. As there is not a single best approach to manage the open innovation activities of a firm, which depends on internal and external factors (Lichtenthaler & Lichtenthaler, 2009), managers must start with a strategy of open innovation that is unique to their company's character, environment, and needs. This approach echoes existing calls by scholars advocating a process of open innovation which starts with strategy (Vanhaverbeke, 2013).

A systematic process of partner selection can help managers find open innovation partners who fit the particular strategy of open innovation of their companies. Indeed, given an open innovation strategy, managers can develop a set of guidelines describing the partners they seek for their open innovation activities, enabling them to more easily identify the partners with whom they can best pursue their strategic objectives. A systematic process of partner selection that builds on open innovation strategy and takes into account the nature of the firm's industry can not only accelerate the process, but also lead to more consistent results from open innovation activities. For example, a strategy for diversification using breakthrough innovation would require looking into distant industries for partners, while in a strategy of advancing an existing competitive advantage companies should look for innovative partnerships closer to home, starting with actors in their value nets players such as their suppliers, customers, competitors, or complementors. Hence, upon embarking on a process of partner selection for an open innovation initiative some partner types are more

relevant than others. In the investigated cases no systemic process was observed for selecting open innovation partners. Alas, we saw evidence that seeking radical innovations is associated with distant partners who do not belong to the value net of companies. Incremental innovations, on the other hand, were associated with value net partners. Managers thus could benefit from a more systematized process of partner selection. A starting point is the formalization of explicit corporate and business strategies. Meanwhile managers should have a good understanding of the ecosystem within which their business operates. An identification of the different actors in this network and the various roles they play. This can then be followed by the formalization of a strategy for open innovation. A perspective which couples business strategy, value networks, and open innovation helps managers identify the directions they should be looking into to achieve their business objectives.

5.3 Research limitations and recommendations for future work

Our findings were based on evidence from four case studies of industrial players where none of the companies investigated had a close interaction with end users such as that in the fast moving consumer goods industry for instance. Knowing that open innovation with customers is a popular trend in industry we found that our data did not provide us with information on the characteristics of this type of engagement. Therefore, further work is needed to explore the nature of open innovation involving end users. In addition, and even though significant variation in open innovation activities was actively sought in selecting case studies for this thesis, an increased number of cases may yield a better insight into other forms of open innovation, such as the typology of partners involved in outbound open innovation compared to that in inbound open innovation. We saw in the case of SCK•CEN where the company pursued inbound and coupled open innovation processes with value net actors while outbound open innovation involved more distant actors. Since none of our other cases pursued an active strategy of outbound open innovation, more evidence is needed in this context.

More generally, we identified some issues relating to the role of strategy in open innovation that can be interesting directions for future work. One such issue is the separation of open innovation activities from conventional business operations in the cases of DSM and Janssen Pharmaceutica. Both companies employed a centralized management of open innovation and dedicated specific roles for steering its activities, all while their conventional business functions were doing business as usual. Thus, we observed that in practice companies do not undergo a transformation from closed innovation to open innovation in the sense that they forsake their old ways and adopt new ones. Instead, these investigated

companies are introducing a process of open innovation that is parallel to their conventional and “closed” R&D activities while keeping the two to some extent separated. It is an interesting question to explore in future research how and when interactions take place between these parallel processes of open innovation and closed innovation. We suspect, based on our case studies that a bidirectional relationship exists between the two where the knowledge flow within one company can leave its closed innovation funnel to its open innovation platform and similarly, leave its open innovation platform back to the closed innovation funnel to be developed confidentially.

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Chapter 6 - Appendix

Transcript of interview with Mr. Robert Kirschbaum, VP of Open Innovation at Royal DSM.

The interview took place at DSM's Innovation Center in Urmond, the Netherlands on August 21st, 2014.

(Description of research)

H: The term open innovation has been applied to various and distinct activities.

R: For example, cooperation with universities has been prior to the introduction of open innovation, it has always been there.

H: Yes, I can also think of another example, searching for Starbucks and open innovation returns the result that Starbucks is pursuing open innovation since they have introduced a platform where users can create a profile, log in, and suggest flavors. They pick an idea from a customer every once in a while and that's open innovation. There is hence a wide user of the term and established scientists in the field of innovation have argued that frameworks of classification are necessary for the conceptual development of open innovation. Following this line of thought, I am investigating whether the type of partner with whom open innovation is pursued is a suitable basis for differentiation. The type of partner here refers to two main categories of actors. In the first category I am borrowing from network management the concept of the firm's value net, which includes the firm's suppliers, customers, competitors, and complementors. This is the first category, the second category refers to actors who fall outside this value net, mainly I am considering universities, research institutions, and other companies who fall outside the value net, meaning firms which are not suppliers, customers, competitors, or complementors to DSM.

R: How about public-private partnerships?

H: Yes that would also be part of the second category.

R: IMEC would be one. (referring to the Interuniversity Microelectronics Centre).

H: Yes definitely, but one involving several partners in this case.

R: Definitely, or the Dutch Polymer Institute (DPI), which is not at all exclusively Dutch because there are Korean, Japanese, Chinese, and Brazilian companies buying tickets to be able to see what is happening in the R&D environment that is partly subsidized by the Dutch government and partly paid for by companies like DSM.

H: So that would fall outside the value net of DSM. and basically, this is describing the type of partners. When it comes to how we're trying to compare these types of partners, I am considering the following points: incentives for collaboration, are they different depending on the type of partner? Also the characteristics of collaboration, thinking about the stage of the innovation funnel where research is focused and whether the research is geared towards incremental or radical innovation. I am also considering the complexities and risk involved in collaboration.

R: Ok, clear.

H: To begin our conversation, I would like to start with the homepage of the open innovation section on DSM's website. The first paragraph, after the title and a few lines of subtitle, the first paragraph reads: "We connect and collaborate, finding partners to team up with in creating solutions for a brighter world. We continually look to grow our networks with academic institution, suppliers, partner companies, even competitors!". Mentioning the type of partners DSM engages in open innovation is important and was used in this case to introduce the reader to open innovation activities at DSM. Why do you think that is the case?

R: I think this is mentioned to give a link to the past when there were only collaborations with universities. It is also kind of shocking the reader when saying it is including competitors. There leaving the message that anyone who wants to cooperate with us after we together have determined that there is a situation of complementarity. (1 plus 1 is 3). And with competitors you have to be very careful, you have to very narrowly define the area of cooperation, and the EU commission will be even very critical and have a look whether you are not trying to fix prices with your competitors in this area, because this is not allowed. I think linking the past to the current situation and future is the objective of this passage on the website.

H: You mentioned an important point on the complexity of open innovation with competitors, which I will come back to when we get to competitors.

R: I may, even now, come to a 4x4 grid which was proudly found at Philips in Eindhoven. The Philips grid, which we use to explain that we have very break-through and new activities, like the Emerging Business Areas of DSM's Innovation Center where the CIO is responsible. These are biomedical, bio-based, and solar. And then we have certain platforms and then we have a big chunk of the business group innovation takes place where mostly incremental innovations are pursued, while in the EBA's this is extremely radical. And what we have learned is that open innovation works better when you are further away from the origin (referring to point of origin on the

4x4 grid). How comes? an emerging business area, where the subject is new to DSM, new to the world, where the market is emerging so it can go anywhere, we don't know which product/market combination is going to lead us to profitability, we see many uncertainties, there are so many questions, that we are willing to share with others. While if we go to the origin, Caprolactam as an example, is a core business of DSM and was one of the core pillars of the growth of DSM. The only truly commodity chemical still in DSM's portfolio. We have a super strong position. We are not so willing to share because we can lose more in sharing than winning. I am saying that the more we get to the upper right corner (referring to the 4x4 grid), open innovation is really useful. It speeds up the innovation process and mitigates the risk. So, this may help you in further understanding.

H: Along the arrow on the grid (starting from the origin point ending with breakaway businesses) the lower we go (towards the point of origin), is incremental innovation?

R: The arrow is from incremental to radical. And open innovation works better along with arrow. and it works best in the upper right corner because of the so many uncertainties and questions that you are willing to share. Think about DSM's high-risk cooperation with POET in the United States, who has 27 bio-refineries all running on corn. We believe that corn should be used to feed living systems, and your car is not a living system. So what we can do for you, and we have the technology, is take the waste from your corn industry, the corn crops, after taking out the corn kernels, and the leaves and the stems, and we can make ethanol out of that. Ok, said the partner, I have the value chain, I have the land, I know about fertilization and growing corn, you don't know anything about it. I also know Exxon, BP, Shell, Caltex. Because they are my customers. Can you come in with your technology and together we can show the world that we can turn waste into useful chemicals. So we agreed on a 50-50 joint venture. The collaboration is high risk though, as it has to compete with the oil industry lobby.

H: What is the nature of the high-risk involved? It is not technology risk because DSM had already developed the technology.

R: Risk is also business risk. It is in this case related to domestic politics. There is a risk of the American administration tightening the belt on bio-based economy. A move which would be heavily applauded by the oil companies who claim to hold the answer to the fuel problem, which they consider to be shale-gas. In this case the prices of ethanol and bio-waste ethanol might go down and the market will not be so profitable for us. But only through open innovation we were able to develop the technology and only through open partnership with POET we are now able to show the world that it is possible but it still high risk because of the context where we play the game.

H: I would like to return to the 4x4 grid, given that we have incremental innovation at the base near the point of origin and radical innovation in the upper right corner, can we also draw partner types as a dimension here as well. Can we say that firms pursue incremental innovations normally pursue them with a specific type of partner, and not another?

R: Correct, correct. Here (referring to the area closer to the point of origin) you would even prefer closed innovation in a joint venture.

H: Can Can we say that there are enough common characteristics across several open innovation initiatives with suppliers to justify grouping them in "open innovation conducted with suppliers". Are they similar in characteristics that we've mentioned. In complexity, in risk, in the stage in the innovation funnel they typically focus on?

R; Mostly, we are open to our suppliers in this part of the grid, where the values are high and the financial effects of changes, small changes, incremental changes, because of the high volumes involved, would move the needle of DSM. In that respect, you can cluster them. But the chance that you will have a similar situation on the upper side of this 4x4 grid is small.

H: You mentioned the collaboration with POET in the United States. This is an example…

R: It's partnership, it's a joint venture.

H: From reading the documentation I am under the impression that the joint venture is more focused towards market access, and supply chain activities. So innovation is not a main activity?

R: Indeed, we did that before, and we did that in a very open structure. And I have published a picture in that which shows our participation in more than 15 public-private partnerships all over the world. I remember the numbers from 2004-2014. Because public-private partnerships, you team up with you promise to pay money, as well as invest in kind, so in man hours, so some were early days from 2004 or 2009 others were later. But in total, we got access to over 450 million euro R&D output. So R&D which has cost 450 million euro for technology. Of course we did not pay all this amount, only a small part, but it gave us access to the solutions which were found in the public-private partnership. The prime example of open innovation in practice.

H: Then you were able to use this technology in the joint venture with POET.

R: Absolutely correct,

H: Can you think of an example of collaborative innovation efforts with a suppliers? I am trying to get an idea about the complexity of collaborating with a supplier.

R: I think it is more complex. There is also the issue of loyalty.

H: Loyalty to the supplier you mean?

R: Yes. I don't think it is that high on the agenda. Loyalty to the supplier. I think the conditions by which we deal with our suppliers are tough. And if they do not agree we go to another supplier.

H: The relationship between buyers and suppliers are based on manufacturing principles. How do you reflect on the case of adding to this relationship the issue of collaborating on innovation?

R: There Is an enormous effect financially, which I tried to indicate before. Because suppliers are the large ones to DSM. There is a big financial effect which overrules a lot. When it comes to collaborating with customers, it is further down the value chain, they can be shown a pilot and see how it works. Once DSM wanted to introduce a new plastic, which is a new nylon with a very high melting point. I was general manager of that business line of plastics. And we started to work with molder who takes our nylon and injection-mold this article. Then they said that the weight improvement compared to metal, steel, and aluminum is fantastic. But we can do more, we can integrate several functions, because we can design the model, and the mold can b e much more complex than the steel mold, or the aluminum mold. Because plastic is like water, it flows like water when it's molten. So we can make it more complex and we can include for example, another structure inside to pre-heat the air when it is mixed the diesel fuel. So in terms of making the article they integrate a few steps and then they can offer a little price reduction. So then their customers are happy. They go to the car manufacturers, and say here we have a lighter engine because this part is mounted on the engine. So you have to go down the value chain with pilots. And collaborating with a customer in that way is less risky and works well. And is very open.

H: Is less risky relative to what?

R: To changes of the systems with the suppliers, where big numbers are in, and slight changes of the profit directly moves the needle of the DSM total profit. With the customer, you can follow what the end user has in mind. That helps introducing new products. But you start small, I think with suppliers you already have an existing relationship, you have large numbers. Don't touch it!

H: Now we touched on suppliers and customers. How about competitors?

R: That is the extreme case. But for example we have, after cooperating for a long time with the company DuPont, which is a similar company to DSM and on the board level we are competing, they also have nylons, and polyesters, and they have biobased propanediol. Which So they're on the same track and definitely a competitor. But we were able to find a n area where we are complimentary, and this is the area of surgical materials. In our emerging business areas we found a possibility to use one the our products in the human body to repair a broken ligament, or to do a suture and not with catgut, or with poly-lactic acid but with material which will stay there until you die. One which will not be touched by bacteria and will not be oxidized in whatever form. In America, the market for biomedical material is much more advanced than Europe's and even much more advanced that other parts of the world. As we do not have access to the American market and to the hospitals there, we have set up a joint venture called ActaMax for surgical materials with DuPont, which is considered to be a competitor.

H: And is this relationship focused on collaborative innovation?

R: It is innovation focused, it is one of the activities belonging to the EBAs.

H: How would you characterize this relationship in terms of complexity?

R: It is complex because they are American. And in American companies the power of the legal people is much higher than in European companies. They have a decision authority while in DSM we say, legal is supporting the business, and if the business is thinking he has a right track, it's allowed to neglect the advance. In America not. The number of legal people per company if you plot, is highest in America.

H: It is complex because of this factor?

R: It's complex because of that, and the different attitude of legal people. It was very complex to set up that deal.

H: Would you say that would be characteristic of any collaborative innovation agreement with a competitor?

R: no, no, it's more American. The American corporate culture, more than the fact that it is a competitor.

H: Can you reflect on the general complexity of collaborating with a competitor?

R: Yes, this is the one which I mentioned in the beginning, which you get extra attention from the European Union. Cooperating with a competitor is risky because of price-fixing. That's what they are afraid of.

H: To discuss one example of an open innovation project from the documentation on DSM's website, there is the project with Marrone, Bio Innovations. The documentation suggests the collaboration was focused on the early stages of research.

R: This particular example is on platforms, not EBAs. EBAs are run by the DSM Innovation Center while platforms are the higher risk, early stage research of the business group. Sometimes taken care of by the innovation center. Another one is Stevia, a natural sweetener that we can make by fermentation, which is our core technology. So we are now teaming up with different players in the market and technology partners to also become a Stevia supplier. This is also a platform. DSM is a technology-oriented company, but we are also a market-opportunity company.

H: There is also the relationship with Buhler which resulted in the introduction of a new product, NutriRice, in China. Relative to DSM, where would you place Buhler's business? Are they a complementor?

R: They are not a peer-company, they are not a competitor, they are a complementor because they knew the market so well They can reach customers which we are unable to reach ourselves.

H: According to the documentation, DSM provided nutrient knowledge and Buhler provided the technology in processing grain.

R: But also they provided market channels. The routes to the market in the far east. This was a crucial role for them to play.

H: Where can that collaborative innovation effort be placed on the 4x4 grid?

R: It was not a break-through area. A step before this.

H: I think we have briefly touched upon the various partners involved in open innovation from within the value net of DSM. We discussed suppliers, competitors, complementors, and customers. Now we're left with the second category. How would you characterize a relationship between DSM and a university?

R: If it's a far away university, we hope that by funding R&D particularly with a professor which we highly appreciate will give us access to good people. So there is a recruitment element which is the first one I will mention. Due to the Bayh-Dole act, where universities by definition own the inventions in IP. The old idea of 'I pay you, you do a good work, and we will patent it and then it is our property.' That is not valid anymore. Because universities themselves patent, or at least they try to. And it is a tough situation because the value is in the future and we don't know whether that patent will survive examination, and if it survives examination, we don't even know whether other companies are going to oppose, saying look this is not valid, look we've done it before. So the value of university patents for us is very much in the future, but ok. we'll pay a little bit, and say, with a running royalty, if we get rich, you'll get also something. This works in Europe, it seems to work in Asia. It does not work in America. American universities have the advantage that universities have become wealthy by selling patents, particularly in the pharmaceutical area, and these universities profit substantially from their patents.

H: and that makes them more picky?

R: Yes, arrogant, for sure. So, your question can only be answered if you include the different areas of the world. The answers are different in different areas of the world. I believe the public-private partnerships is a very European thing, maybe even a northern European thing. it's a kind of answer to America where a lot of the R&D is government and military sponsored. So we are going to set up top institutes and public-private partnerships and the government says if DSM brings in money and the university brings in money, we double that. The Dutch Polymer Institute is an example which was founded more than 12 years ago.

H: Is BMM also an example?

R: Yes, Biomedical Materials is also a public-private partnership.

H: Would you say the research here that DSM is involved in is more early EBA< more fuzzy front end research?

R: Yes you are absolutely right. For the biobased I gave you the example of the 2004-2014 and 15 public-private partnerships worldwide which we have invested in. For biomedical there was BMM and CTMM, where we invested in combination of money and in kind to get access to what was developed.

H: And once a result crystallizes of this research?

R: We have access to it, and access is enough, it doesn't have to ownership, we can arrange the use. I have a slogan in Dutch, "Delen is her nieuwe hebben". Our EBAs are designed to address and bring solutions to the biggest problems of the world. It would be arrogant to say we can do it with closed innovation because the best scientists and innovators only work for DSM. So we have to have the network to the other areas in the world, where new startup companies are mushrooming, where the best professors are inspiring young people and develop new things. We have to be there, we have to be at MIT, at Harvard, at Stanford, but also in Shanghai and Singapore. We have to be there and we have to do things together because it is high risk, very high risk. We don't know if we are sharing potential future profit or loss, anyhow it is better that we share it.

H: And do you think, reflecting on this high risk in EBAs, that certain partner types fit in EBAs such as with universities, or collaboration with more distant partners, do you think that the fact they go here while (on the grid) which suppliers go here and competitors go here. Is this coincidental or do you think it has to do with this high risk nature of EBAs?

R: I have not thought about this before. So I have to think whether I have an answer to your good question. I think the science community, universities, in some cases are really driven by ideology which fits our ideology or the EBAs. We have to solve major problems, but that's not true for all professors and all universities. If they are driven by that ideology, they directly feel a march with DSM.

H: How about firms that are outside DSM's value net? How about open open innovation with firms whose business is completely foreign to DSM?

R: Like metal companies? because metal companies are not in our A group.

H: Is there an open innovation collaboration with these companies?

R: Yes there is. The steel companies also understand if they can save weight in structures their customers will be happy. This is the case when their customers are train or car manufactures. Consider the BMW i3, there is a lot of carbon fiber-reinforced parts.

H; Would you describe that as incremental innovation or radical innovation?

R: This example that I give is radical innovation. Another example is Roquette, which is definitely not in our value system. Can we have a collaboration with them? Yes, because they supply the joint venture (Reverdia) with agricultural feedstock.

H: Wouldn't you say that DSM's EBAs are a form of cross-industry collaboration? in its EBAs DSM is introduced entirely new industries and they have to work across their current market and the actors they are familiar with currently.

R: Yes, if we go back 10 years I would say that POET is outside our value net. And Roquette is outside our value net. But as soon as we can see that we deliver something very unique to them and we team up with them and create something together in a joint development program and then a memorandum of understanding and then a joint venture agreement, they become part of the value net.

H: But prior to that, initially,..

R: They were outside the value the net and foreign to DSM.

H: And as you characterized the collaboration with POET as high risk for other reasons such a political reasons. Would you say that same for Roquette?

R: To a lesser extent, but there was also a risk.

H: Would you add that to the general complexity of dealing with a company that was previously foreign, operating in a different industry?

R: No, that risk comes from external factors. Like the shale gas example for the DSM-POET joint venture. And as for the Reverdia (Bio-succinic acid), it was due to Japan having patents on all Poly-Butylene-Succinate uses and blends. You can imagine a whole forest of patents. And it's led by Mitsubishi Chemical.

(Concluding remarks)

(End of transcript).

Transcript of my interview with Mr. Eric Snoeckx, Director of Open Innovation and Networking at Janssen Pharmaceutica, subsidiary of Johnson & Johnson. The interview took place at the campus of Janssen Pharmaceutica in Beerse, Belgium on Friday September 12, 2014.

[Introductory talk]

H: Can you give us an introduction about open innovation at Janssen Pharmaceutica and your work in this context.

E: Our goal is to create added value for our functions, and I am doing that with open innovation and networking. Typically going in areas where we as a pharma company have never looked at. So they [the functions] are looking in their core areas. I am informed on a global level of their middle-term strategic directions and that is my agenda, they are looking in the core and I am looking in places where they have never looked at. I try to pick up opportunities which could be part of the solution. And that is the way we can create additional value because they have never looked to these directions.

H: With regards to my research, I am investigating whether partner-types is a suitable basis for differentiating open innovation practices. Here, I am focusing on two main categories of partner types, the first is value-net partners. These are actors within the value-net of the firm, so basically, customers, competitors, complementors, and suppliers. This is the first category. The second category are actors that are outside this value net, and in my study here I am focusing on are universities, research institutions, and also firms that are completely outside the business of the firms.

E: I do think that a third category under your outside the value net is the government. Because we always have affairs and relations with government bodies but also typically in my field it is also in other departments, other areas of the government.

H: I like to start my questions with the website of Janssen Pharmaceutica where by clicking on the Open Innovation section a brief one paragraph introduction of open innovation at Janssen is shown. The paragraph says, "We collaborate with external parties in every stage of our value chain: from early discovery up to commercialization. We search for medical breakthroughs wherever they take place, regardless of whether it is at a university, research institution or in other pharmaceutical or biotechnological companies." This statement is of interest to my study because it mentions two important things. First it mentions that Janssen seeks open innovation engagement on several stage of the value chain. Secondly, it mentions also the type of partners involved. It mentions universities, research institutions, and companies. My study investigates the connection between these two points. I am investigating whether we can link the different types of partners mentioned in the statement with different value chain stages. For example, is collaborating with a certain type of partners more associate with a certain stage in the value chain or not?

E: I am looking five to ten years ahead, that is my agenda. Typically driven by where our global functions want to be or where they see hurdles. That's my agenda. I am not interested in what they need tomorrow. That's for the purchase department. So typically it means in a lot of cases if I reach out to suppliers of us I am not interested in what they have currently on the market or what they are currently doing for us or delivering with us. I am interested in is their strategic agenda. What do they have in the development in that organization and not what you find in their catalog. The catalog is the business of purchasing department. Short-term interactions or improvements is also the business of purchasing department. I am only interested, if I do a reach out to our suppliers, what do they have in their mind, what is their strategy? It is a big difference for me. What is their strategic direction?

H: If we actually talk about suppliers in particular, since you touched on this topic. How does the existing familiarity with them affect talking to them?

E: What I do as a first step in interaction with a supplier or with a new business or with new academic department. I try to build a relation and trust. That is a first step, always. Whenever I want to interact, I spend the first time in building a relation and trust. Once you achieve that, then you can talk about strategy, because that is normally done behind closed doors. I only will tell something which is normally said only behind closed doors after we have achieved a relationship of trust. So first step is trust relation, which takes a while. Goes from nine months to twelve months.

H: But a supplier is already someone you are familiar with.

E: But I am not talking with the same, account manager or the sales manager of the suppliers, that is the purchasing department. That is why I mentioned it. I am talking with the management or with the people involved in the strategy or the innovation part. Mostly strategy or management. Those are whom I am talking with. And that is completely different. So coming to your question then, is there a link between stages in the value chain and the type of partner? I would say no. There is no link. Meaning, let's stay with very early research, of course a lot of interactions are happening with academia but, to give you an example, also, most businesses, and in this case with our competition, we have set up a platform on a European level, IMI, and this is a pre-competitive platform from the pharmaceutical industry defining projects or defining challenges and opening up towards the academic world, but it is pre-competitive meaning that it is sponsored financially by for instance, ourselves, and also with our competition and then the work is done in collaboration with academics. So even in that very early stage, there is also the partners could be even our competition, the partners could be businesses. Also, now under the Horizon 2020 program, they opened up the IMI-2, they extended the scientific and technology area beyond pharmaceuticals. Meaning they opened up towards technology companies. Because maybe the future solutions are not only based pharmaceutical sciences but could be in link with biology and technology companies. So the other ones could also be businesses or academics. So even in that early phase there is also businesses involved in it, but also academics. And for me, that applies across the whole value chain. Maybe what could be different is say the ratio, could be, but that is case-by-case, I am not making differences, for instance, for our manufacturing, I could do a reach out to the academic world, but also to a company. There is no straightforward relation.

H: Considering the fuzzy front end, where there is high uncertainty.

E: In that fuzzy, front end, companies are sitting around the table, meaning business-to-business, and even in this case competitions, and then doing a connection /to the academic world.

H: Is that as easy to do as in the late stages of the innovation where a solution has been defined.

E: If you follow the development of a drug and then you can say, once it is in manufacturing, then there is more business-to-business, if you strictly look at the drug. But the solution is solved for the drug but not for the manufacturing of the drug. Maybe there you need expertise or solutions and then you can go to either to a company or you can go to the academic world. But that's more for the problem in the manufacturing process, technology, things like that, that are other problems.

H: So far we have touched upon suppliers, competitors…

E: and new companies, meaning business companies which are not our suppliers, and that is the majority. So I am more looking into companies we have never dealt with. I am more looking into this new companies which we did not know before.

H: Why would you say you are looking in that direction? Why not for closer actors?

E: We are part of Janssen Pharmaceutica in Belgium. We have set up a strategy for the company here in Belgium. We are more or less a landlord, these are all global functions, they can leave from one day to another if they want. We do not manage these functions, they are managed on a global level from somewhere else. We do not have any control or management authority to say that they have to stay here, so what we can do besides being a good landlord, is create value for them. So I am looking in other areas where they do not look at for their problems. So we try to give them as much as possible value for being here. So that is our strategic agenda.

H: How does looking in distant industries create value?

E: First you invest in your network, you get to learn who is in my region here, who is doing what. They [the functions] do not know that. They have a problem, they want to be somewhere in five years from now. What I can do is I can make connections, from different disciplines or expertise or technology or science, which makes a total solution for what they are looking for. And they are looking for. and they have never looked in that direction. They look very specifically in their own core areas. So I can do totally different things, which sometimes can create synergies that can provide better answers for the problems ahead. So that's value.

H: If I go back to universities, Janssen has, according to the documentation on the website, collaboration with several universities, one of them in the University of Hasselt. And it is an R&D partnership. How does this collaboration take place?

E: We have collaboration let's say with maybe all the best universities across the globe. In the past, if we got a collaboration it was more that we were in control and managing the collaborations because at the end we paid for it and we received the knowledge. That's how the collaboration with the academic world used to be. In essence, we pay for the knowledge which is delivered or created. So we are in control, we manage. Also in the past, when a researcher collaborates with a university, it is a university they know, for example if they had studied there. So

you play in the backyard of the academic world. The speed of creating knowledge is equal to the speed created at the department, and you are very narrow and you don't look at the other options in other academic partners or universities. That's not bad, but there are thousands of them, and we were not able to manage that. Sometimes it is done on a personal basis. Today with the University of Hasselt we identified domains of expertise where we believe that in that domain together with our domains, we could find solutions in certain areas. but we didn't specify the projects as such. So it is more on the program level in domains, and we committed among each other that we will look for more collaboration in the next 3 to five years. And this is different from what we used to do in the past. And we are doing the same with other universities. We define more partnership, instead of defining a project.

H: These projects are then directed towards unexplored areas?

E: It could be, most of the time yes unexplored or, defined around a challenge. Such as an early diagnostic for Alzheimer's. That's a domain.

H: How do you reflect on the complexity of dealing with university as opposed to dealing with a company in the context of open innovation?

E: If it is a small company, that is not complex but if you touch for instance to large companies, such as Siemens, it more complex than a university. In general, you need to deal with someone who has an oversight of what is happening in the organization, someone who knows the internal network.

H: I was also reading about the ExaScience LifeLab in Leuven. This groups five universities and Intel in addition to Janssen.

E: This is an example of looking in these new areas.

H: I am focusing here on the difference between dealing with five universities and a global player like Intel.

E: Intel is an example of an actor that normally our people would never look to. The challenge here what with handling big data. To extract knowledge from big data. The goal was to increase the speed of DNA sequencing, we are currently hindered by the limits of the current technology. By talking with iMec, who was working with Intel on developing the next generations of transistors for supercomputers. So by talking to them I said, could we not develop next generation transistors specifically for computations in life sciences. And that is how we Intel, iMec, J&J, got connected with the five universities.

H: With regards to the global functions at the campus of Janssen, can we say that these functions look more for incremental innovations while you are looking for radical innovation.

R: What they are doing is that a chemist is looking into chemistry, a biologist is looking into biology. They will never do a reach out to an engineer.

H: Another example you mentioned is small companies, also one of the things the senior vice-president said, he identified academic institution and small spin-off companies are breeding places for new medicines and cutting-edge technology. How are small companies different?

E: It is different in a way that you have to protect these companies, they are afraid to work with multinational. If you want to work with a small company, of course first you have to build trust.

H: When you say protection, do you mean legal protection?

E: Yes, you need to understand that you need to protect.

H: How is that different from dealing with large companies, for example, Janssen with another large pharma?

E: A large company is used to do these legal proceedings, for small companies this is unknown. A big company is used to dealing with these issues.

H: Do you perceive any risk when dealing with other partners in the context of open innovation?

E: No, the way I am working I am investing in a relation and in trust. I do not want to talk about any confidential information. It is not needed. I want to keep it as long as possible outside the confidential talks. Once we know this is what we want to do, then we go for the CEA.

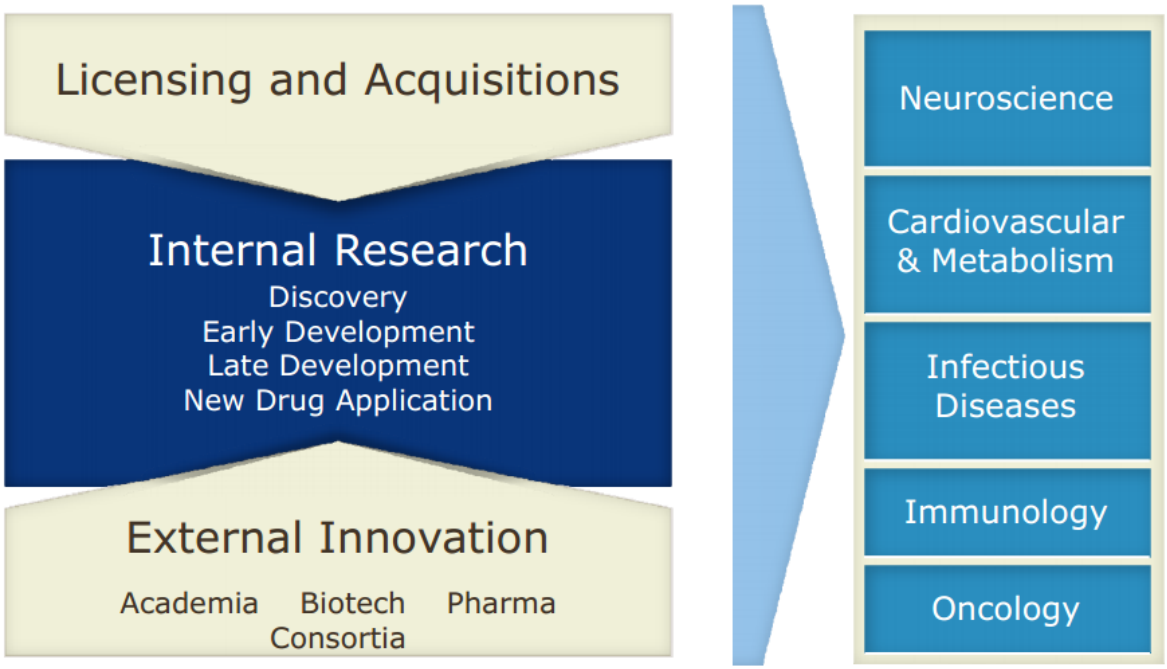
H: Even when dealing with the competition?

E: Even when dealing with the competition, it is not needed. In that phase when you are building relations and trust. Once we identify that then the lawyers come on board.

H: Would you associate break-through, radical innovations with collaborating with distant partners more than with the competition?

E: Yes, more than. I think you have more chance to have a disruptive innovation working with distant knowledge areas than what you do normally in your field. I think the chance to find something disruptive is higher.

H: I would like to ask you about a diagram from the documentation on open innovation at Janssen Pharmaceutica: [Mr. Snoeckx was shown the diagram below - property of Janssen Pharmaceutica]:



The four stages of internal research highlighted in the diagram and four sources of external innovation, can the type of partners be linked to the stages mentioned?

E: No, in R&D, because this is a slide from R&D, from a global function. This is what our R&D is doing, they do L&A and now they have extended this to external partners. And these are the partners they collaborate with. But there is no relation between the type of partner and the stage in the value chain. There is not a one-to-one relation between the two. The ratio, however, of course that changes. If you look for example to the front end that's more academic than business. and the more you go to the later stages you will find more business than academic. But also it could be a mix. Also, collaboration can be entirely with academic partners and it could be entirely with business partners. Secondly, considering drug products the line extending from the early stages of the innovation funnel to the later stages goes together with increased financial commitment because at a certain stage it is impossible, even for VC, to invest in it, because it cost too much, that's where the big companies come in. Also, small actors do not have the infrastructure to develop in the later the stages of the product.

H: If we were to dissect the term business partners to its various components, mainly suppliers, customer, competitors, or complementors. Are some of these types of business more suitable partners at certain stages in innovation?

E: Competition is more associated with pre-competitive work, early stages of development. I think suppliers are associated with a later phase, most of the suppliers for us in our industry are lab suppliers, delivering raw material to the lab, not ones you can jointly innovate with.

[Conclusive remarks].

Transcript of my interview with Mr. Dirk Ceuterick, Deputy Director of Business Development & Support at SCK•CEN. The interview took place at the campus of the Belgian Nuclear Research Centre in Mol, Belgium on 16 September 2014 at 10:00.

[Introductory talk]

D: There is a need for increased valorization of our work here at SCK•CEN. Part of our working means comes from the federal government, so we have a endowment on an annual basis but this endowment is not sufficient to cover all our expenses and labor costs and so on. So on top of this endowment we have to make sure that we have sufficient income to cover all our costs and pay the people which are working here at SCK•CEN. So it is a similar amount to the government endowment that we have to earn on our own by performing contract research and performing analysis. In order to do so, we have 700 people working here with a very small business development and valorization department. This is what we are doing here at BDNS group. We are also responsible with everything related to the protection of intellectual property. That is managed here at BDNS. Patent applications and such.

H: Reading the documentation I found a lot of information about openness in SCK•CEN's activities, when searching for R&D partners, the section on innovation on your website reads "SCK•CEN collaborates with companies, research institutions, universities, etc". Can you tell us more about this?

D: Yes, we are by definition a public research institute, our activities are mainly in this context, this is in contrast with a company in industry. In our case the main part is to do research and the smaller part is how to make the links towards industry. And this is one of our goals in BDNS to strengthen and diversify the link between industry and the type of research that we are performing. There are some good examples within SCK•CEN where specific research lines have led to the establishment of a spinoff company. We are not very used to that. And it's one of the ideas that we have in our strategic direction. One of the possibilities of valorizing our internal research might be to set up a spin-off company together in collaboration or a joint venture with a company from industry or other research units like a university and so on. This is an area where we have to grow. I think there is one example I can mention, a company that is called DoseView. It is a spin off by one of the people formerly working here at SCK•CEN within the EHS institute. A technology was developed to visualize the accumulated dose in patients undergoing radiotherapy treatment. It was a technology developed here at SCK•CEN and now we have put it in a small spin off company. The aim is to further develop that concept, it is not a product yet which is finished and ready to be put on the market. As in many cases when we are talking about development which have to be applied in the medical field. It is quite a long time between the actual invention of a certain new drug or drug discovery and afterwards the real implementation. It is a quite lengthy and costly process before having something ready which can be used on human beings. There is animal testing and clinical trials so it takes quite a lot of time and we are not able to raise all the funds and the money to do so. So the idea was to do it in a separate company where the aim is further develop the concept and in future collaboration with other companies maybe in the medical area that they would co-invest in that spin off company. We are jointly thinking with an external company for a way to integrate this technology into their existing product.

We are also increasingly trying to identify research activities in a very early stage which have a high potential for legal protection and valorization whether or not in collaboration with industries. Collaboration with industry in interesting in that sense because quite often they have they own sales organizations or their own commercial activities and sales networks which we do not have. It would be crazy for us to set up our own sales force and start contacting hospitals to sell our products. It is much more efficient to join in a very early stage with a company which has an existing networks to these hospitals.

H: Is the spin off in question still owned by SCK•CEN?

D: Yes, a majority of the shares is owned by SCK•CEN. But they also have received some external funding.

H: Does SCK•CEN get involved in the management of DoseView and its collaborations?

D: Yes, because we are present on the board of DoseView as a main shareholder.

H: Would you say that the pressure on research institutions to raise funding on their own due to insufficient government subsidies is acting as an incentive for research institutions to commercialize their research?

D: From a personal point of view, I would say so. When you come to the conclusion that the federal subsidy you receive is not enough anymore to cover the personal costs of the employees at the organization it makes you think of course about a way to increase a revenue that we generate. First of course we try to cut costs, but then we start looking at different possibilities to increase this. Also we have to look into better pricing for our services, prices that are better related to the real market value of these activities. This is also a way to increase our revenues. Next to that of course you have to look very carefully into the spectrum of the activities you have at SCK•CEN. It could be that there are some areas that are not cost-effective. In this case some of these activities can be discontinued and we can direct the labor towards other activities. We also need to change the reward

culture within SCK•CEN. Now most researchers are rewarded by having their scientific output in scientific journals. We should have a parallel trajectory for our researchers working on activities that are kept from journals and then these researchers can be rewarded based on the IP value of their research and its valorization. This is something that needs to be worked on with the Human Resources department.

When talking about open innovation at SCK•CEN. There are quite a lot of collaborations in the European framework programs. The Horizon 20/20 program which is financed by the European Commision and then there are the EuraTom funding lines. I think these are examples of open innovation activities. Why? Because you have strong collaboration between different Nuclear Research organizations on a certain topic, or on a certain domain. Due to the fact that you have to collaborate on a certain research project, this implies a certain openness in your collaboration in your innovation. There are also possibilities to have industrial companies involved as well in these projects. This means there again you have this drive to involve industry in your projects and make sure that the research you are performing has a certain industrial value and applicability. Next to that we have quite a lot of collaborative projects with similar research organizations like ours which are not funded by the European Commission for example but which are then more financed by a certain consortium of industrial companies. They can be energy companies which are putting money together in order to perform certain research projects. It can be on Nuclear materials, or structural materials, and so on. It is a platform where research organizations and industrial users of the outcomes of research collaborate.

H: You mentioned a few times price-setting for the products and services of SCK•CEN. What would you say those products and services are?

D: For example, typical products are Isotopes such as medical radioisotopes which are used in medical imaging and also in cancer treatment. There are other types of isotopes which have industrial applications. We are provide the service of radiating certain materials that are supplied by companies and then returning the irradiated materials to them. So by this price-setting to the outside world we have to make sure we are covering our costs. We have to think about the real value of our products and services taking the market into consideration. We do all that with the goal of reinvesting the outcomes back into our research. We are not a company as such, we are a public utility and it is not our ambition to set up commercial activities. But what we can do of course is participate in spin off companies and set up joint ventures with other companies. But we will never commercialize on a high level under our own name. To do that the best way for us would be to set up a spinoff company. So you have to look for strategic partnerships. We focus on external companies and which partner to choose. It's like a marriage. We have to find a partner which fits with us and the sum of the two entities has to be more than 1+1, it has to be 3 or 4. The partners must strengthen each other allowing each partner to achieve goals which they would not have been able to achieve on their own. This is of course another challenging process, partner selection. Our department can help researchers in the organization find partners to set up spin off companies and such.

H: When looking at cooperation with an industrial partner, do you perceive common characteristics which differentiate collaborating with industry as opposed to collaborating with another research institution?

D: I think a very important differentiator is the fact that with a company from industry there is a clear drive towards financial revenues and so on and this is not the case when collaborating with other universities or other research organizations. So when a company wants to invest and wants to join with you in a certain project there is always a clear aim to regain what they have invested and more of course. That is very clear. A very interesting case here is about setting a new production in one of our reactors for a very specific type of radioisotope. We are in negotiations with a large chemical company and the point there is that they see us more as a pure supplier of this radioisotope than a partner, while we are aiming to set up some kind of partnership. We need to find workout partnerships with companies that are more than buyer-supplier relationship. But it's a process which takes time and which requires a lot of negotiation. I also think when collaborating with an industrial partner we can make use of their commercial network.

H: With regards to this example, can we say that SCK•CEN is playing the role of a product supplier rather than its traditional role as a research institution?

D: The collaboration started when the partner was a small company of about 50 employees but then this company was bought by a large multinational company so now we have to deal with the multinational, which is completely different. For them we are one of the players in their huge pipeline. Our relationship with the first company was on a friendly and collaborative basis but with the multinational it is a very different relationship.

H: Does SCK•CEN do contractual research?

D: Yes we do. For example, we do a lot of research consortia in the area of development of new structural materials to be used in nuclear environment or new fuel materials. These areas of research are quite lengthy and costly. The work is divided between several nuclear research labs in Belgium and abroad then we put together the results and share the results among the parties involved.

H: What does SCK•CEN get from this type of collaboration?

D: One is the revenue from the labor that is done. But also we get an insight into the research of the other parties involved in the consortium.

H: How would reflect on the complexity of collaborating with research institutions like in this example as opposed to collaborating with companies?

D: The difficulty lies often in protecting the results and that you do not have a clear idea on how your research will be treated by the other parties involved in the consortium. Also there can sometimes be 10 to 20 partners involved and so it become difficult to manage the collaboration and its outcomes. On the other hand collaborating on a one-to-one basis with an industrial partner it is easier to clarify ownership. Also they are different in the sense that industrial companies want a return on their investment on as short as possible of a timeline. This is not always the case in research consortia, sometimes you see that a certain research project has been going on for 10 or 15 years and may not necessarily have a clear means for valorization.

H: Another dimension I would like to explore is the issue of radical vs. incremental innovation. Am I correct in thinking that considering the nature of SCK•CEN's research area, being nuclear energy, that most innovations here are incremental in nature?

D: I think you are correct. I would agree that in most cases it is incremental innovation. On the other hand, when you look at more radical innovations, those are then put in a separate unit. There is another range of space-related research activities, because cosmic radiation which astronauts are exposed to is similar to the normal nuclear radiation. So we have quite a lot of research work in that areas.

H: Is this research work done in collaboration with others?

D: It is funded by the European Space Agency which is funding collaborative research projects with different research organizations which are then joining up in these areas of research. Actually, while working on developing a type of algae strains that are resistant to high doses of radiation, which can possibly be used on future space missions, we discovered that these type of algae has shown a potential effect of lowering cholesterol in humans. It was kind of a side-effect of the research. So now we are talking with some Dutch companies about the possibility of setting up, again, some kind of spin-off with them for the development of this microalgae strain and to perform some additional research in order to identify what elements in this algae the chemical components that are producing this effect. So again, this is an example of an application not directly related to our research, so we are looking to develop it externally. Other than that I would say that most research done here today at SCK•CEN is of the incremental type. Any other research of the radical type would then be put in a separate entity. Why? because it is no longer closely linked to nuclear technology. In this example it became more about food additives.

H: And how are these negotiations going with the Dutch companies to further develop this research?

D: We knew them from the ESA project, so they were already familiar to us. And so it was a logical step for them to approach us for performing additional research in testing this strain of algae. We did not look actively for partner in this case, but they found us. We are still going through the first steps in a long trajectory. The next stages would then be testing on mice, then identify the active ingredient in this algae, then it has to be tested in clinical trials on human beings, then a production system needs to be developed, and then you go to the market after getting approval from the appropriate authorities.

H: Is SCK•CEN going to be involved in any further steps in the development of this product?

D: Yes. In the search for the active ingredient we are active in this area right now. When it comes to production it is not our business area. And then collaboration is needed when it comes to sales capabilities. It is a costly and risky route to take before the product reaches the shelf.

[Conclusive talk]

[End of transcript]

Transcript of my interview with Dr. Peter Simpson, Director of Screening Sciences and Compound Management at AstraZeneca.

H: Kindly tell us about Open Innovation at AstraZeneca and about your work in this regard.

P: I am responsible for collaborations to bring in new targets from the external academic world. We have set up these collaborations with key centers in different countries. Also, in order to access the rest of the world we have set up the Open Innovation web portal that covers a variety of modules where external scientists can interact with AstraZeneca directly. I am part of the leaderships of that web portal and so I am responsible for one of the modules directly.

H: When reviewing the open innovation projects listed on the website and with regards to the web portal, there were several modules directed at different stages in the innovation process, some were early stage and some were late stage. Is the module you are responsible for one of these?

P: There is about five of us who run the whole portal together. So it does cover all aspects of the drug discovery process. We each take responsibility for one of the those modules. I am responsible for one, but I am also part of the steering committee of the whole portal.

H: And with regards to open innovation in general, who is responsible for its management on a corporate level? and how was open innovation adopted by the company?

P: Probably we have taken a bottom-up approach whereby those individuals who saw good opportunities and pursued them. In recent years we have started to coordinate these activities among each other.

H: So the management of open innovation is distributed among several individuals?

P: Yes. I guess part of our philosophy of open innovation is not to have someone in charge of it. I know some other companies do it that way. We have adopted the approach of individuals setting up initiatives and looking for new opportunities based on their experience and knowledge. So there is not someone in particular in charge of it.

H: I have been reading on the open innovation section of the website of AstraZeneca (openinnovation.astrazeneca.com) and I noticed that the open innovation was somewhat separated from the main site.

P: It is the five of us who set that open innovation portal up. And it is deliberately a deliberately separate portal away from the main site.

H: Why is that the case?

P: Because we wanted more freedom to design it and make it easier to access. The main website of AstraZeneca has a lot of different purposes. So we wanted a website with a single purpose.

H: On the main website and there is a section that describe AstraZeneca's partnership strategy in the five core areas of the company's activities. So there is a section describing how the company looks for partnerships. But on the open innovation section I found that the company is seeking open innovation collaboration on that same five core areas. So I would like to ask if you see any difference between the more traditional partnerships and open innovation partnerships in these areas?

P: Sometimes yes and sometimes no. If you think about it organizationally, so within the oncology areas, which is a large department, there will be people going to major opinion leaders whom they know in oncology and look for opportunities to work with those key opinion leaders. Or if we have a particular project on a particular type of cancer and we will go and identify the people we need to work with to advance that project. So that is the more traditional pharmaceutical partnering approach. A particular project or a particular molecule and we go find the right person who would solve our problem.
What we are trying to do in open innovation is that we do not what we do not know. We do not know who else would have a solution or an idea or an insight. So the open innovation portal is not targeted towards particularly famous people, it is available to anybody with a bright idea that we may have not come across otherwise. That's the key difference in the philosophy.

H: Referring to this difference, is it related to the stage where you are looking, or is it a difference in the type of people targeted?

P: So within the therapy area largely the partnering is with people we already know, known leaders in the field whom we will identify and approach directly. Open Innovation is about anybody in the world approaching us directly with their idea that we might not know about.

H: Referring to the well-known players who are traditionally approached by AstraZeneca for partnering on innovation, are these normally suppliers, competitors, complementors, or other types of actors relative to AZ's business?

P: There is a variety, it is hard to generalize. But let's consider an example, we have got a late stage project, we are looking to position it in the clinic, in a particular indication, there are three or four world leaders in that indication who may already be running clinical trials in that indication with other molecules, clearly we would often approach them, either for a conversation or a collaboration. But within our open innovation portal, the vast majority of projects we form will be with academics.

H: Why would academia be the most prevalent here?

P: We do have partnerships with other pharma companies. But it is not open innovation, it is a project we have signed with lawyers and confidentiality for a specific reason. Open Innovation is more speculative, more of a learning opportunity, a win-win. One could imagine doing open innovation with a supplier but actually that is a whole different thing. What we are trying to do is learn and find new ideas. Not buying those ideas but developing them together. So that does not really fit with most of our commercial partners. But much more likely to work with academics, who are also interested in advancing the science.

H: When viewing Open Innovation in this case as a learning opportunity, would that normally translate to pursuing projects in unexplored areas?

P: What we are looking for is new commercially viable ideas and projects. Inherently we are looking for things that we have not already thought of or done. So they would have a degree of risk associated with them that is higher than we would tolerate for internal research. A higher level of risk but also an attractive level of reward.

H: While reading about AstraZeneca's open innovation activities on the company's website I came across a project sponsored by the American National Institute of Health (NIH) where AstraZeneca and two of its competitors, Pfizer and Eli Lilly, were involved. Can you tell us how this collaboration took place?

P: In that model, AstraZeneca was not collaborating with Pfizer or Lilly directly. We were collaborating with NIH, Pfizer was collaborating with NIH, and so on.

H: So it was an indirect collaboration?

P: That is correct. There is at least one example of collaboration that I led between AstraZeneca and Bayer which on some level you can define as open innovation, but at the moment the majority of our open innovation projects are done with academics, which is something likely to continue for the foreseeable.

H: How would you describe the interaction with Bayer?

P: It is a broader collaboration which covers a number of different projects at one time.

H: How would you compare collaborative innovation with academia versus that with industry partners?

P: Perhaps a good example there is a the European Lead Factory which is a multiparty innovation and collaboration with I think 10 universities and 7 pharmaceutical companies and quite a lot of biotech companies. And it was an enormously complicated undertaking to have everybody in that framework to agree. The pharma companies, some of which were very collaborative from the start, others find it very difficult to think in this way. So it is not really about which sector is more difficult, it is about the actual experience of the individual party and their enthusiasm for collaborative innovation. For example, we already had this collaboration with Bayer, so they were extremely easy to work with in the European Lead Factory because we already had a lot of these concepts agreed on. With other pharma companies which have never done this before it was difficult to get them to the same point.

H: How would you reflect on the complexity involved in those collaborative innovation undertakings?

P: Some pharma companies find it difficult and some academia find it difficult. So it does come down to the individual. It is difficult to generalize. It varies enormously in academia and varies enormously in industry. What I hope is true is that as people are increasingly being involved in those collaborations they are becoming used to is and it is becoming an easier process.

H: I would like to ask you about the specific platforms for open innovation on AstraZeneca's web portal. The portal includes several platforms each associated with a certain stage in the drug development process. The platform associated with the earliest stage is New Molecule Profiling, and then Target Innovation, Pharmacology Toolbox, and Clinical Compound Bank. External parties can be involved in either of these activities. However if we take the earliest, New Molecule Profiling, based on your experience what kind of participants submit proposals in this stage?

P: What we are looking for in that module is external academics probably, but not necessarily. Chemists who have a library of small molecule they already made, or are making, but they do not have a direct link to bioscience people to do testing.

H: And how about Target Innovation and the later stages?

P: With the next stages the major difference in the type of participants is that they are normally biologists, rather than chemists. When it comes to the last stage, the Clinical Compound Bank they will be clinical investigator rather than biological researchers, clinicians already conducting clinical trials.

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