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Open Source Innovation Networks: Exploring High and Low-density Models

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Abstract

The concept of open innovation, of which open source software is a well-cited example, has grown in popularity over the past decade. Firms engaged in open innovation leverage external knowledge to accelerate innovation and exploit innovation more effectively. One way in which firms can connect with external sources of knowledge is by participating in value networks with a multitude of external stakeholders. Nevertheless, there are few studies of open innovation value networks, with relatively little known about the characteristics that impact such networks. We seek to address this gap by exploring the networking arrangements of eight European firms that have a formal strategy around open source software (OSS). The findings reveal that firms selectively engage in two types of value networks in order to benefit from open collaboration and innovation – one a high-density network comprising a limited number of familiar partners, the other a low-density network comprising a larger number of often unknown partners. Additionally, these networks are influenced by certain characteristics such as the level of commitment, knowledge exchange, the alignment of objectives and governance.

Keywords: Innovation Network, Open Innovation, Open Source Software

1 INTRODUCTION

Open innovation is a practical model that proposes that firms use external as well as internal ideas and knowledge (Chesbrough et al., 2008). Although the term is relatively new, all organizations, to some extent, interact with their external environment to source ideas and knowledge and collaborate on innovations (von Hippel, 2001; Cohen and Levinthal, 1990). Indeed, the literature is rich with studies describing the importance of networking (see for example, Nelson, 1991; Freeman, 1987; Arora and Gamberdella, 1990; Pisano, 1991; Joynt, 1991; and Powell et al., 1996). However, in contrast with extant literature on external collaboration, open innovation advocates working with a multitude of external stakeholders; interestingly referred to as a 'swingers club' (cf. Kock and Torkkeli, 2008) of firms engaged in innovation; always searching for new linkages or possible relationships that enhance the innovation potential of participants. Consequently, open innovation networks are characterised by multi-directional relationships, representing a value network rather than a value chain (Thomas, 2008).

Value networks consist of several connected individuals or organizational actors that transform and transfer various complimentary resources and capabilities (Helander and Rissanen, 2005). These value networks place equal importance on both external and internal knowledge as sources of innovation. In prior theorising about innovation and inter-organisational relations/networks, external knowledge played a useful but supplemental role as the firm was the locus of innovation and activities within the firm were the central object of the study (Chesbrough et al., 2008). However, the open innovation model advocates that firms become members of diverse ecosystems that hold the distributed knowledge that is key to the innovation capacity of individual firms. Thus, in times of changing and complex knowledge-bases, the locus of innovation will be found in these networks rather than in individual firms. These networks are viewed as vehicles for producing, synthensising and distributing ideas and increasingly the success of a firm is linked to the depth of their ties to network partners (Simard and West, 2006). Nonetheless, it has been suggested that in the pursuit of open innovation, firms choose a more conventional 'going steady' (cf. Kock and Torkkeli, 2008) approach, focusing on interactions and collaboration with a limited number of familiar partners. With the exception of one working paper from Kock and Torkkeli (2008) and a practitioner article from Pereira (2007), there is little empirical research that examines how and why firms engage and cooperate with multiple stakeholders in open innovation value networks. Where firms do engage in value networks, their predilection for steady, familiar, relationships over relationships with multiple participants within an open, global market is unknown. In general, little is known about firm participation in open innovation value networks, as previous research is oriented towards transaction-based inter-organisational networks. Therefore, there is a need to explore this area in more detail.

Thus, this study explores the networking arrangements of eight European firms that have a formal strategy around open source software; a frequently cited exemplar of open innovation. In particular, it focuses on how and why firms engage in open source networks and examines the attributes that influence such networks. The surge of literature around open innovation is rooted in the success of open source software (OSS) (Penin, 2008; West, 2007). Additionally, open source software (OSS) is regarded as an excellent exemplar of open innovation as in both OSS and open innovation, the word 'open' refers to the competence of sharing ideas and knowledge across firm boundaries and using greater sources of information and knowledge to create value (Pereira, 2007). Section 2 presents the theoretical background for the study. This is followed by a description of the research method (Section 3) and a presentation of the findings (Section 4). The findings reveal that firms employ value networks to gain better access to external knowledge, ideas, competences and new collaborative arrangements with partners, customers etc. What is also evident is that firms engage in high and low-density networks in order to benefit from open collaboration and innovation. Both types of networks enable firms to share resources, leverage ideas, enhance innovation, as well as their reputation, and tap into each other's expertise which in turn derives more value for the companies, and ultimately their customers. However the effectiveness and strength of these networks is influenced by particular

characteristics; specifically the level of commitment, knowledge exchange, the alignment of objectives and governance. We conclude by presenting some avenues for future research (Section 5).

2 BACKGROUND

Research suggests that a firm goes through various stages in becoming increasingly open (Pereira, 2007). In this regard, a firm can be located on a continuum that ranges from fundamentally closed to completely open (see Figure 1). As organisations become more responsive to external ideas and knowledge, they inevitably move away from the closed model of innovation. In the next stage, the firm develops new collaboration models that forge strong linkages with complementary firms, open source communities, etc. As firms become more open, they also become more adaptive; often developing innovation platforms to coordinate work with many participants and innovating their own business models in addition to permitting experimentation with alternative forms of business including spin-offs, joint ventures and start-up companies (Pereira, 2007). According to Pereira (2007) and Torro (2007), in the pursuit of external ideas, competences and knowledge, firms should use networks as an external resource pool. Other research has supported this argument; suggesting that collaborative value networks are essential in order for open innovation to succeed (Cardosa et al., 2008; Perkmann and Walsh, 2007; Vanhaversbeke and Cloodt, 2006). Nonetheless, in a survey of 131 Spanish firms, Kock and Torkkeli (2008) found that contrary to the interpretation of openness as firms scanning the entire market for new ideas or knowledge and partners, firms instead preferred a serious of bilateral exchange relationships with a more limited number of partners.

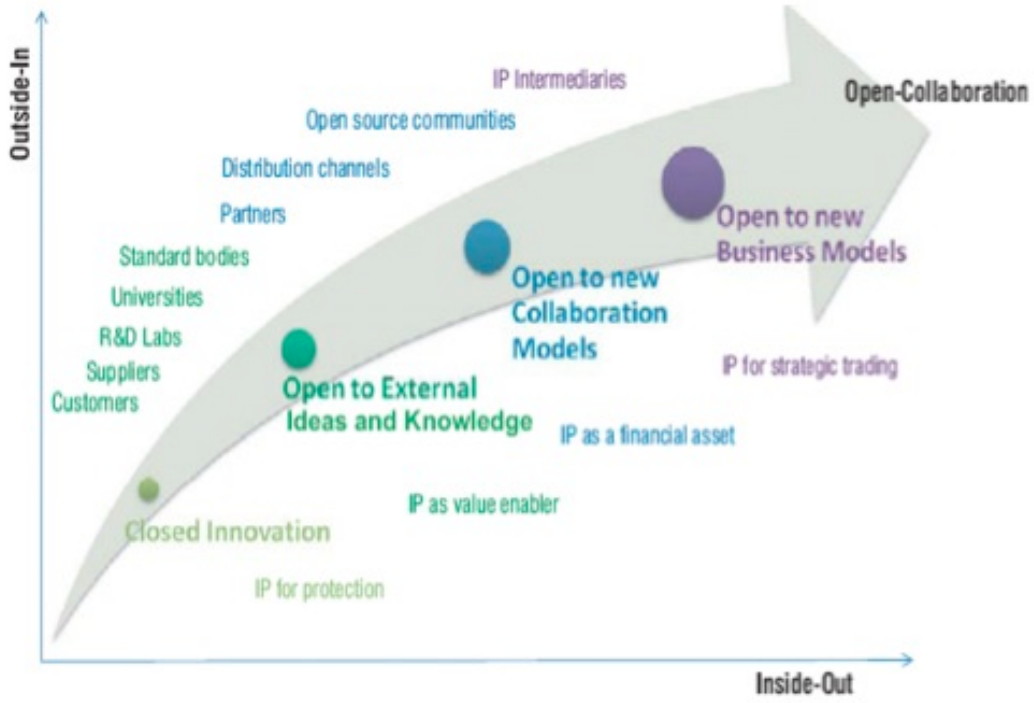


Figure 1: Open Innovation Adoption Curve (Source: Pereira, 2007)

Open innovation value networks are viewed as important vehicles for enabling and building on inter-organisational collaboration (West and Gallagher, 2006), as they are key conduits through which knowledge flows from the external environment to the firm and vice versa (Simard and West, 2008). In a value network built around the development of open source software (referred to in this study as an Open Source Innovation Network (OSIN)), relationships between the firm and the OSS community (users and developers) are more important than inter-organisational relations. However, West (2007)

has highlighted the importance of having competitors in a firm's value network, as competitors often collaborate to further develop or stimulate adoption of a shared technology. Research suggests that a number of key attributes influence or determine the strength of these networks. First, there needs to be commitment by network participants. In a value network, value is co-created or co-produced. Thus companies with complementary resources or capabilities have to be fully committed to cooperate with each other. Each partner should also be able to derive benefits in order to remain committed (Vanhaverbeke, 2008). Second, access to complementary skills and a broader knowledge-base, which facilitates knowledge exchange, positively influences the ability of participant firms to innovate (Simard and West, 2008). Knowledge exchange within a network facilitates joint learning and fosters problem-solving, while the integration of complementary resources enables joint creation of products, technologies and services (Parise and Henderson, 2001). Third, the alignment of objectives in a network is important as "creating value cannot be done unilaterally based on the efforts of a single, focal firm, nor can it be done without keeping in mind the different and divergent interests of all collaborating partners" (Vanhaverbeke, 2008, p. 218). Finally, the resources and capabilities of all network participants need to be integrated and governed. Trust and a unifying vision therefore play important roles in bringing disparate partners together in a value network (Gomes-Casseres, 2003). However, leadership and the absence of internal competition among participants in the network are crucial (Lorenzoni and Lipparini, 1999; Gomes-Casseres, 2003). Firms have to actively nurture the value network to manage potential tensions or conflict between participants. Additionally, a firm has to make a number of arrangements with other participants to remain within the network, e.g. offer incentives such as access to information, compensation etc. (cf. Vanhaverbeke and Cloodt, 2006).

3 RESEARCH METHODOLOGY

The study aims to explore how and why firms engage in open source innovation networks and examine the attributes that determine the strength of such networks. The study was categorised as exploratory due to the scarcity of empirical work in the area of open innovation value networks. Thus, Marshall and Rossman (1989) suggest that either a case study or field study research methodology can be used. The researchers decided that a field study would be appropriate as it would facilitate the collection of data from a larger number of organisations and would form the basis for more focused research at a later stage. Data collection was carried out using semi-structured interviewing based on a common protocol in eight companies that operate in different networks (see Table 1). Twenty potential study sites were contacted with a view to securing their participation in the study. However, preliminary analysis revealed that the approach to open source networks was more operational than strategic in some of the companies and they were eliminated from further analysis. The choice of study sites was based on the company's history of engagement with OSS. Specifically, we choose focal firms engaged in activities such as embedding OSS in products/services, or in suites of applications, sourcing the software from communities, and active involvement in OSS communities. Firms that simply used OSS products for cost saving purposes were excluded from the study. Interviews lasted between forty-five minutes and two hours. Content analysis was undertaken using open, axial and selective coding techniques as described by Strauss and Corbin (1990). This form of analysis facilitates the development of substantive theory without prior hypotheses (Baskerville and Pries-Heje, 2001) and can be utilised in the absence of, or in conjunction with, existing theory (Strauss and Corbin, 1990). In the initial phase, 'open coding' was used to determine the main ideas in each transcript. These ideas were then grouped by significant headings informed by Figure 1, e.g., how responsive or open they were to external ideas/knowledge from universities, suppliers etc., new collaboration models with partners or communities or new business models around OSS, and key network characteristics derived from the literature such as commitment, knowledge exchange, governance and alignment of objectives) to reveal categories and sub-categories. The next step involved 'axial coding' which is the process of relating categories to their sub-categories. The researcher utilised NVivo Qualitative Data Analysis software to facilitate the process of analysis. This

included non-hierarchical listing of categories, known as free nodes. Identifying free nodes was found to be useful to record initial ideas and emerging categories in early open coding. As a list of codes began to emerge, the analysis moved to a higher or more abstract level; looking for a relationship between the codes. Once a relationship had been determined, the focus returned to the data to question the validity of these relationships. During this stage of analysis, the context or intervening conditions in which a category occurred was examined (i.e. what types of OSS networks do firms operate in or what types of attributes influence members' relationships in these networks?). Category processes were also examined which involved looking at the actions and interactions performed in the context or intervening conditions (i.e. how do members in the network operate?). The analysis also involved looking at the intended an unintended consequences or outcomes (i.e. what value arises from the various activities that take place in the network?). The researcher did not stop coding for properties and dimensions while developing relationships between conceptual during this phase of the coding. Additional dimensions (not already identified) emerged for a number of concepts (e.g. high density networks and low-density networks). Categories and sub-categories were represented in NVivo using 'tree nodes' which were used to code category/subcategory data. As coding proceeded, it became clear what concepts were categories and which were subcategories. The final step, 'selective coding', is the process of determining a core category (e.g. value network). The core category is that category that is mentioned most often and is usually connected to most of the other categories.

Name	**Business**	**Informant**
APC, Germany[1]	Telecommunications Services	Product Manager
AB Systems, France[1]	Electronics and Systems	Segment Manager (2 interviews)
Bredex GmBH, France	Consultancy and Training	Chief Executive Officer
OPS, Germany[1]	Business Software	Manager of OS Initiatives Program Director OS Program Manager
Osmosoft, British Telecom	BT's Innovate and Design Open Source Innovation Capability	Head of OS Innovation (2 interviews) OS Strategist Developer Head of Technology
Prismtech	Performance Critical Middleware	Product Manager
NRC, Finland	Telecommunication Services	Director of OSS Services (2 interviews) Head of Software Technology
KTD	IT Products and Services	Open Source Compliance Officer

Table 1: Companies Studied

4 FINDINGS

Two types of OSIN were evident from the analysis. The first resembles a high-density network characterised by steady, long-term relationships of familiar partners while the second represents a low-density network of a larger number of often, unknown partners. The activities that take place in both types of networks are shown in Table 2 and further discussed in the following subsections.

[1] APC Germany, AB Systems, OPS, NRC and KTD are pseudonyms to protect anonymity

		High-Density Networks of Familiar Partners	*Low-Density Networks of Multiple Partners*
Level of Firm Openness	External Ideas & Knowledge	• Outsourcing to familiar sub-contractors. • Collaboration with universities/research institutes. • Participation in OSS research projects and working groups	• Participation in OSS communities. • Make use of social media and host events and forums.
	New Collaboration Models	• Strategic alliances/joint ventures with familiar partners	• Joint ventures with new complementors. • Establish and lead communities around OSS.
	New Business Models	• Not open to new business model per se but rather complements that add value to their core activities such as product delivery, support and integration	• Partnering with intermediaries • Establishing new ventures around OSS and experimentation with new complementors/ competitors

Table 2: Examples of how Firms Engage in Different Types of Networks

4.1 High-Density Networks

All of the firms in the study operate in high-density networks of familiar partners that provide capabilities, experience, resources and services that complement firms' product or service. These firms are responsive to external ideas and knowledge from their various network partners. This type of openness manifests itself in the form of bilateral, recurring exchange relationships and agreements between firms and subcontractors, or in strategic alliances or joint ventures over a long-term period. Additionally a significant portion of firms' revenue is devoted to certain suppliers or subcontractors with which they have repeated exchanges. For example, in their efforts to draw on external ideas and knowledge, APC Germany collaborate with stakeholders in a high-density type network of strong ties. The Product Manager in this company explained that progressing to a more open model is quite slow at the moment. As he pointed out "it would be wishful thing". Additionally, the company is more secure in conducting relationships with familiar commercial companies where they pay for a particular service, than with OSS communities where they prefer anonymity. However, this respondent added that there is a need to access knowledge that is often to be found outside the boundaries of the firm. To do this, the company outsource work to subcontractors that they are well acquainted with and who are well known in the OSS communities. In a sense, the company "outsource this kind of community sharing" (Product Manager, APC). The company also participate in open source conferences and collaborate with many universities and research institutes. Additionally, there is a move towards establishing new open collaboration models with a new initiative underway involving a consortium of partners, including APC, which aims to investigate governance practices for open source in industry.

It was also found that in many other cases, the development of high-density networks occur as a result of certain employees representing the company in collaborative international research funded OSS projects involving research institutes, companies, universities etc. These established linkages also tend to manifest themselves in other departments in the organisation with common areas of interest in OSS. Over time, these cooperative linkages become more personal, with employees exchanging information and ideas with individuals in other organisations in an informal capacity. For example, the Segments Manager at AB Systems explained how they are involved in some research programmes and OSS working groups. Additionally, they have some joint ventures and strategic alliances with familiar partners. However, this company have established clear links, where necessary, with familiar network partners to ease product support, integration, delivery etc., (activities that compliment their existing business model). Even so, this manager explained that they are open to new collaboration models and always on the lookout for new opportunities. The study also revealed that working with a familiar number of complementors in high-density networks results in access to technologies, standards, the ability to work and exchange useful information, innovation, capabilities and ideas and finally the potential to work with others towards a common goal. As the Segments Manager at AB Systems

further explained, "you can only do so much on your own. By sharing, discussing and exchanging with other people, you do not need to be experts in all domains because you get ideas. So you need to network". Nonetheless, while firms operating in high-density networks are open to external ideas, knowledge and new collaboration models, they are not as receptive to new business models around OSS. Rather these firms consider themselves open to complements, i.e. support, product delivery etc., or features that add value to their existing activities. Thus, they work with and draw on the expertise and knowledge of existing, familiar complementors.

4.2 Low-Density Networks

In addition to being members of high-density networks, several of the firms, i.e. Osmosoft, the NRC, Prismtech, OPS, KTD and Bredex, also participate in low-density networks of multiple partners. This type of network is also considered extremely effective because it enables firms to further develop technologies with new complements that increase the value of their existing customer offering. Additionally, firms choose linkages with multiple partners to avail of benefits such as access to solutions and ideas they never considered themselves, specialised knowledge or capabilities and the potential to co-create products together. For example, the Program Director at OPS revealed, "networking is a core element of open source value creation to the customer. Open source cannot work unless you network with a larger community, including other companies and customers". Moreover, several of the firms are open to new business models, partnering with open innovation intermediaries to further develop new technologies around OSS, as well as being open to new collaboration models with new complementors to explore the potential value of new technologies or increase the value of their existing products and services. The Director of OSS at NRC described how they network with multiple stakeholders on a global basis, which has resulted in successful collaboration models for the company. This Director believed that it was extremely important to integrate oneself into an open network of complementors because in this way the company can not only influence where a technology is going and ensure that it fulfils the company and customer needs, but the firm knows better what is available, what parts of the technology they want to utilise and what aspects they want to leave out of their product. Firms operating in low-density networks increase their visibility inside and outside the network and thus they have more effective access to potential customers all over the world than in the traditional model of closed innovation. The OS Program Manager at OPS described how for some projects, known participants are invited for co-innovation of open source technologies. If the technology reaches a certain level of maturity, an open ecosystem where any organisation can join in is preferred. Other projects are often initiated on open source platforms such as SourceForge.Net or Google Code to seek the utmost level of feedback and adoption. Additionally, this manager explained that while they are open to new collaboration models, they are also amenable to the idea of new business models. For example, the company have partnered with the IP intermediary, Innocentive and have a license agreement with Intellectual Ventures, a company focusing on IP and innovation.

Both Osmosoft and Prismtech are also open to external ideas, knowledge and collaboration models and have successfully networked with many stakeholders in order to optimise this level of openness. For instance, the Head the OS Innovation at Osmosoft described how they run a successful open source project: the web-based client-side wiki platform TiddlyWiki. This manager believed that there was much to be gained from open collaboration that is centred around enterprise software solutions and so, the group in this division aspires to working in as open a manner a possible and making extensive use of social media such as blogs and Twitter. Besides participation in the TiddlyWiki community, the group participate in a number of other communities; primarily those engaged in the development of web-based collaboration and open web technologies. Similarly, the Product Manager at Prismtech described how they are open to new business models around OSS and work with new complementors, including competitors and commercial partners that develop modelling tools for their technology. For example, the company network with teams of people from other companies including competitors. These network members meet twice a year to outline plans for products and gain

feedback from each other. Members also work together on open source technologies, sharing the costs of innovation, the benefits and the risks involved. This manager further explained that while the company has a number of steady relationships with companies, they have established more alliances and linkages with unfamiliar companies and developed new collaboration models around OSS. For example, one company developed an advanced UML modelling tool for one of Prismtech's products without any financial investment from Prismtech. This company began the process of development by contacting Prismtech through a community developer mailing list and posting questions. As the manager at Prismtech revealed, "obviously we were interested in it but we probably never would have paid them to do it. Why? Because it was not top priority for us. We use our own money to invest in our core product. However, they contributed to expanding our product further by innovating on top of it".

4.3 Network Attributes

The analysis revealed that certain attributes influence both types of networks in different ways (see Table 3). These are discussed in more detail below.

	High-Density Networks	**Low-Density Networks**
Commitment	A high level of commitment does not need to be demonstrated on an ongoing basis. Trust and credibility have been established as a result of long-term, repetitive relations and thus a moderate amount of commitment is sufficient	Require a high level of commitment if firms want to be taken seriously and seen as an active and credible contributor. The greater the level of commitment, the more trust is created among network participants
Knowledge Exchange	Exchange of knowledge tends to be precise. Firms engaged in steady networks believe they do not have time to be exchanging knowledge that is not specific to their needs.	While not always specific, there is a high level of diverse knowledge exchange. Firms engaging in low-density networks believe their potential to innovate improves two-fold as a result of disparate knowledge
Alignment of Objectives	Objectives are aligned and a common goal and vision is shared in the network. What each participant is working on makes sense to all involved and there is a win:win situation for all participants	As there are more stakeholders, aligning objectives is often more difficult. Firms need to realise that things may not turn out exactly as they envisage. This is part of the risk of engaging in networks with multiple stakeholders
Governance	More informal safeguards in place as a great deal of trust, familiarity and transparency has been enabled due to long-term, frequent linkages with a limited number of partners.	Governance process tends to be more formal with some restrictions imposed by legal departments, steering committees, formal agreements etc.

Table 3: Characteristics of Networks

4.3.1 Commitment in a Network

The level of commitment displayed by various members in a network is essential for long-term survival and sustainability. If commitment is not visible in a network, then various participants will not contribute the required resources or knowledge required for certain open source initiative or projects. Frequent interactions and collaboration by all participants is a vital requirement. High-density networks survive because of the long-term commitment continuously displayed. Additionally, this long-term commitment has enabled a huge amount of trust to be built among members in the network. On the other hand, forming networks with new participants requires a higher level of commitment. For example, the Director of OSS Services at NRC and all of the managers at OPS explained that as newcomers to a network, you need to portray a high level of commitment through hard work and by engaging very actively with network participants. Only then will one be accepted to the network and recognised as a true contributor. As the Director of OSS Services further elaborated,

"if you come to a network as an outsider, it's like going to a foreign country without you knowing the language or knowing the people - you don't know how to get around. So you need good communication and collaborative skills. Once you get into that country, you start learning the language and so forth and then you know you can start doing so much more ".

The study revealed that commitment needs to be ongoing in both types of networks, otherwise the innovation and collaboration that is taking place may cease at some point. Thus, there is lot of management support in the various companies for the time that employees expend networking and collaborating with members in a network. Several of the firms have teams of people in the company whose reward incentives are tied to working and collaborating with open source communities. The OS Strategist at Osmosoft, BT also described how they are resolutely committed to the TiddlyWiki community among other communities and stressed that it must remain this way in order for the company to continue to successfully deliver on behalf of BT customer solutions that are built upon community technology platforms. The commitment takes two forms: the contribution of code and other efforts, e.g. software testing, to the TiddlyWiki community; and financial support of the non-for-profit association which owns the copyright to the core technology and operates the developer community infrastructure. Moreover, in their efforts to strengthen ties and forge sustainable relationships, the majority of the companies host various face-to-face events for network participants and, in some cases, cover the travel expenses of members. Nevertheless, it was also found that accomplishing commitment in a network is often difficult, particularly in a low-density network, because the mind-set of open collaboration is difficult to achieve among employees in organisations, particular if they are not well acquainted with partners. Thus, there needs to be motivation among network participants to stay committed to the network because in some cases, it can take long periods of time before one sees results. Firms should have an authentic set of interests in the network such as the potential to co-produce something together with a view to improving their visibility and reputation in the marketplace.

4.3.2 Knowledge Exchange in a Network

Substantial knowledge exchange in both types of networks was also found to be extremely important as access to new and diverse knowledge facilitates mutual learning and innovation. The Director of OSS Services at NRC pointed out that the knowledge exchanged in a network is very different between participants and that "you don't need to have an all inclusive common great knowledge about everything that's happening….it is those individuals who know their own area. And we need to trust that those people are experts in their own area". Often the knowledge that is exchanged in high-density networks tends to be more precise and specific to company needs and goals. Those companies operating in high-density networks believed the preciseness of the knowledge made it more valuable as they do not have "all day to be exchanging knowledge". In contrast to this, forming new linkages and relationships in low-density networks require a high volume of knowledge exchange, something that enables companies to access new and diverse knowledge that further improves their customer offering. As one manager pointed out "somebody else from a different industry context proposes a solution that has never crossed our mind, so now when you get these people involved in the same project with a different background, then you can really innovate" (Director of OSS Services, Nokia). Thus, the more knowledge that is exchanged, the more this facilitates learning as one is learning something new and innovating on these new ideas. There are public discussions, mailing lists, wikis etc. to support the various types of knowledge exchange. Thus, if one is willing participate in the network, they will be able to access the information and knowledge that all members have, whilst sharing and building on each others' ideas. For the majority of the firms, face-to-face interaction was believed to be important for superior knowledge exchange, especially with new network participants. As the Product Manager at Prismtech revealed "you can do many things by using emails, reading newsgroups and blogs but it is better if you have a face behind the comments". The Project Manager at OPS also explained that there are many cases where the company have a lot of research projects that are often discontinued inside the firm. The majority of the time, the firm contribute the results of these

various projects to open source communities. He believed that this results in quite positive feedback from the community in an area that is not beneficial to OPS per se but something that is often seen as very valuable for the community. Most of the companies frequently attend various open source and technical events where they meet potential new network participants and host public events on a regular basis where members from the network are invited to participate. Good communications, mutual trust and collaboration with network members was viewed as vital in enabling knowledge exchange.

4.3.3 Alignment of Objectives in a Network

The alignment of objectives was also viewed as being crucial in coordinating and sustaining both types of value networks. However, while it is important that objectives are aligned, inevitably each participant will have divergent objectives. The important thing is that there is common ground between all members in a value network; otherwise the network will not survive. If objectives are not aligned, this may result in a major split of opinion in direction, and if network participants waiver off in different directions, this would send out unclear messages to other members and hamper the long-term sustainability of the network. Thus, it was believed by all firms that a clear vision and goal that comprises a win-win situation for everyone in the network is vital. As the Director of OSS Services at NRC further elaborated,

"in a network, you get access to people who have the same goal and want to develop that technology in the same direction. But then it requires that there are enough similarities in our goals. Like where do we want to take it and that calls for discussion and openness because the minute we don't have that goal, it's very hard to keep the community together".

Similarly, the Program Manager at OPS explained that when you are dealing with multiple stakeholders in a relatively unfamiliar OSS network, there is a need for negotiations and consensus and decisions need to be made. All participants want to gain something from the network. However, the Segments Manager at AB Systems explained that often there is no holy grail to solve everyone's problems but what you find in a network is that there are building blocks that participants can share with each other to arrive at concrete solutions for all. Moreover, when firms get involved in networks with a multitude of stakeholders, alignment of objectives tends to become more difficult. As the Manager of OS Initiatives at OPS further explained, "since they are more stakeholders, this (i.e. alignment of objectives) might be more difficult but this is the way to go, I believe. You have to step away from the idea that in the end it will all turn out exactly as you wanted it to. That's part of the risk". However, it was found that given time, a high level of commitment and knowledge exchange, it becomes easier to reach consensus and more effectively influence others in low-density network about the company's ideas and opinions.

4.3.4 Governance in a Network

The level of commitment, volume of knowledge exchange and successful alignment of objectives depends on the effective governance of resources and capabilities of all participants in a network. While the benefits of networking are evident for most of the companies, OSS networks come with a number of potential risks, i.e. legal risks, support risks etc., and hence a more formal governance process, especially for those firms engaging low-density networks with a magnitude of sometimes, unknown stakeholders. Interestingly, many of those firms that engage in high-density networks have a more informal governance process, due to the familiarity of partners and long-term relationships. On the whole, however, a number of formal and informal procedures govern firm involvement in open source communities and networks All of the organisations in this study have certain rules on how to conduct and interact in networks and participation is subject to reviews and advice from legal departments, steering committees, technical advisory boards, internal reviews and formal agreements. Subject to successful reviews, the exchange conditions that follow in the network tend to be very informal, especially at the operational level. However, while there was consensus among the firms

that it was a good thing for engineers to communicate with engineers in other organisations, they need to be aware of company policy around OSS collaboration and networking. As one manager further explained, "this doesn't mean that every conversation has to be monitored but engineers need to look at the bigger picture, at the global company strategies" (Segments Manager, AB Systems). However, this same manager believed that all employees should be given enough flexibility to exchange knowledge and information with others outside the firm. This type of flexibility increases as a result of repetitive, ongoing relationships with partners and strong ties are forged. Thus, the governance process becomes more informal and less stringent in that there are little restrictions imposed on how to collaborate and interact in these networks. Even so, the process of collaborating in a network is an educational one whereby people need to be taught to participate. Nonetheless, the Product Manager at Prismtech argued that, 'too much structure often kills innovation. It is important to establish point-to-point relationships in an open manner with as many stakeholders as possible". This manager further described how they have more of an informal governance process. The company has a technical advisory board of competent people in place to oversee collaboration in OSS networks. The OS Strategist at Osmosoft, BT also described how the company have an open source operations team whose principal function is to support open source governance activities such as those associated with operating due diligence. The operations team provide a service to anyone within British Telecom who requires guidance in connection with open source matters and draws upon a knowledge base that takes into consideration aspects like security, shared best practice, community principles, relevant company strategy, company policy etc. Where there is a desire to engage in external networks, there is a process to follow and the open source operations team typically take that individual or team through the requisite steps for participation. The OS Strategist at Osmosoft, BT pointed out that this enabled a more informal process. On the whole, all of the firms in the study agreed that it is essential for companies to have a mixture of formal and informal safeguards in place.

5 DISCUSSION AND CONCLUSION

This study has contributed to our understanding of open innovation value networks by investigating one type of network, the OSIN. This study make clear that firms engage in value networks in their quest for external knowledge, open collaboration and innovation that is not to be found within the confines of their own organisations. As a result of their membership in these networks, firms are presented with the opportunity to share costs, leverage ideas, enhance innovation, in addition to their reputation, and attracting complements and improvements to their existing products and services. Given the openness of a network, the power to innovate collectively and the ability to keep costs to a minimum, participants believe they can present a more attractive value proposition to their customers, in the form of complements, lower prices and better solutions. While we acknowledge that the existing literature is rich with descriptions outlining the importance of networking, the same cannot be said for the extant empirical literature on open innovation value networks. This study compliments existing work by identifying two types of networks that firms participate in for OSS value creation and the types of activities that take place in each network. These types of networks can, respectively, be considered akin to what Granovetter (1973) refers to as networks of strong and weak ties. On one hand, high-density networks of strong ties represent those where firms and partners are closely acquainted, while on the other hand, low-density networks of weak ties resemble ones where firms are less likely to know either other. However, researchers such as Kock and Torkkeli (2008) have suggested that the term 'open' may just be a relative one as firms can practice open innovation in high density, steady type networks, something that we argue is evidenced in this study. However, others may claim that this type of network conflicts with the overall characterisation of an open innovation network, i.e. multi-directional relationships and new linkages with multiple partners. Nonetheless, while there are positive benefits to participating in high-density networks of familiar partners, there is the possibility of firms becoming too accustomed to these types of comfortable, exchange relationships. This could limit their possibility for more linkages and exchange relationships in low-density networks. Those firms participating in high-density networks may need to reconsider their

potential to access low-density networks, given the diverse knowledge and expertise that is shown to reside in such networks. While strong ties in high-density networks result in access to external ideas/knowledge and product improvement, weak ties in low-density networks can provide a greater potential for new innovations. Thus, firms should reach further into their steady networks to access the knowledge and ideas of partners/customers of existing partners. Indeed, existing informal networks may lead to more formal arrangements to cooperate and collaborate with complementors in low-density networks. Additionally, it can be argued that in achieving a high level of commitment and knowledge-exchange, alignment of objectives and effective governance, firms participating in low-density networks have the potential to strengthen any weak ties that may exist. As Friedkin (1980) pointed out two decades ago, weak ties have the potential to promote occurrence of solid phenomena. We believe that this phenomenon could indeed be open innovation – in particular its implications for firms engaging in innovation in low-density networks.

Nonetheless, the findings here are based on a small number of firms so replication studies are needed to gain further insights on open innovation value networks. Future research needs to refine our understanding of low-density versus high-density networks. For example, comparing and contrasting these types of networks in more depth and identifying the benefits and challenges of each in the open innovation context would be worthwhile. Moreover, examining formal and informal processes for shared governance that supports open and collaborative interactions and knowledge exchange in high and low-density networks is a worthwhile avenue for future research. For example, the study revealed that individuals in firms often share knowledge informally with others outside the firm that share a common work identity. Thus, managers need to recognise the opportunities possible for knowledge exchange and innovation that arise from their employees' embeddedness through informal network ties and consider investing more time and resources in developing these informal processes. Overall, it would be worthwhile hearing others' views on this aspect.

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