



OPAALS PROJECT

Contract n° IST-034824

WP 12: Open Source Software Innovation and Socio-Economic Models for Digital Ecosystems

Deliverable 12.13: Case Studies on the Role of Partner Networks in OSS Value Creation and Capture Processes



Project funded by the European Community
under the “Information Society Technology”
Programme

Contract Number: IST-034824

Project Acronym: OPAALS

Deliverable N°: 12.13

Due date: M48

Delivery Date: M50

Short Description:

The aim of this document is to examine the role of partner/value networks in open source value creation and capture processes

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Made available to: OPAALS Community

Versioning

Version	Date	Name, organization
1.1	31/07/10	University of Limerick
1.2	23/08/10	University of Limerick

Quality check

Internal Reviewers:

(1st) Thomas Kurz, Salzburg University of Applied Science, Austria

(2nd) Chris Van Egeraat, National University of Ireland, Maynooth

Dependences:

Achievements*	This work was published in the Journal of Information and Software Technology, and presented and published in ECIS 2010 Conference and the Third OPAALS Conference proceedings. In addition, the work is currently under review for publication in Journal of Strategic Information Systems.
Work Packages	Extensive contribution to Workpackage 12 and also the OPAALS community and larger research community as a whole.
Partners	All Partners –The emphasis on the importance of networking, community, knowledge and information sharing in an open, transparent manner has implications for all involved.
Domains	Domains of Open Source Software, Business Models and Open Innovation are extensively discussed in this deliverable
Targets	Targets include: Domain researchers, OPAALS Community, Industry
Publications*	Published: Morgan, L., Feller, J. and Finnegan, P. (2010) Value Creation and Capture

	<p>with Open Source Software: A Theoretical Model for Understanding the Role of Value Networks, in Proceedings of the 18th European Conference on Information Systems (ECIS), University of Pretoria, June.</p> <p>Morgan, L. and Conboy, K. (2010) Exploring the Role of Value Networks for Software Innovation, in Proceedings of the 3rd OPAALS Conference, Springer Lecture Notes (LNICST).</p> <p>Conboy, K. and Morgan, L. (2010) Combining Open Innovation and Agile Approaches: Implications for IS Project Managers, in Proceedings of the 18th Conference on Information Systems (ECIS), University of Pretoria, June.</p> <p>Conboy, K. and Morgan, L. (2010) Beyond the Customer: Opening the Agile Systems Development Process, in Journal of Information and Software Technology (in press)</p> <p>Conboy, K. and Morgan, L. (2010) Future Research in Agile Systems Development: Applying Open Innovation within the Agile Organisation, Agile Software Development: Current Research and Future Directions, Springer-Verlag</p> <p>Under Review:</p> <p>Morgan, L. Feller, J. and Finnegan, P. (2010) Understanding the Role of Value Networks in Value Creation and Capture with Open Source Software, Journal of Association for Information Systems sponsored Theory Development Workshop, St Louis, December.</p> <p>Morgan, L. and Finnegan, P. (2010) Strategic Open Source Software – How Firms Create and Capture Value, Journal of Strategic Information Systems.</p>
PhD Students*	Lorraine Morgan
Outstanding features*	The role of value networks in value creation and capture with OSS is an underexplored area, especially when focusing on how firms network in the open innovation context. In addition, OSS as a form of open innovation is a relatively new phenomenon. Thus, this deliverable has been very beneficial in providing a better understanding of the role of networks for software innovation. The work has also been accepted for journal publication and was also presented at the ECIS and OPAALS conferences.
Disciplinary domains of authors*	Lorraine Morgan, University of Limerick

The information marked with an asterisk () is provided in order to address Recommendation n. 4 from the Year 2 review report*



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EXECUTIVE SUMMARY

This deliverable compliments and extends that of deliverable 12.11 (Benefits and Drawbacks of OSS: An Examination of Value Creation and Value Capture in OS Business Models) in phase II. It also compliments deliverable 8.2 from the first phase of the project (Inner Source Principles) as it demonstrates how the inner source model enables open innovation networking within an organization. We believe that this deliverable has huge relevance for the OPAALS research community as it provides a better understanding of the role of networks surrounding OSS value creation and capture processes, which has direct implications for comprehending digital ecosystems. What stands out in particular from this deliverable as being most transferable to the OPAALS community is the emphasis on continuous commitment collaboration, knowledge-sharing and learning in a network in an open and visible manner, something we feel is crucial in sustaining digital ecosystems. In D12.11 in phase II, it was found that collaborating as part of value network was an important aspect in creating and capturing value with open source software (OSS). Thus, the study aimed at examining this in more detail. Open source software is seen as an excellent exemplar of both peer production and open innovation. Nevertheless, the use of OSS as a form of open innovation is such a recent phenomenon that many unanswered questions still persist. The very concept of OSS represents phenomena that require firms to rethink their strategy as the shift in focus from ownership to one of openness requires a reconsideration of the processes that generate value creation and capture. In responding to this research gap, this deliverable begins with a theory building process for examining OSS value creation and capture. In particular, various theoretical frameworks employed for value creation and capture are explored. The findings of this analysis reveal the importance of a value network for value creation and capture with OSS and uses theoretical propositions to illustrate relationships. We then used two case studies to test our propositions.

1. INTRODUCTION

The objective of this deliverable is to explore the role of partner networks in creating and capturing value with open source software (OSS). Partner or value networks can also be thought of as ecosystems as they provide a means for organisations to collaborate and share knowledge and ideas in an open and transparent manner. This in turn facilitates the development of new open business models for superior value creation and capture. The deliverable forms part of workpackage 12 which focuses on OSS innovation and socio-economic models for digital ecosystems. As the digital ecosystem promoted by the OPAALS community distinguishes itself on the basis of its open source and peer-to-peer nature, this deliverable is extremely beneficial in understanding the role of a network in OSS value creation and capture processes.

Open source software (OSS) is seen as one of the most well-established examples of peer production (Feller et al., 2008; Benkler, 2002) and also a pioneer of open innovation (West, 2007; Gassmann and Enkel, 2006). Open innovation is a model where firms commercialise both external and internal resources to generate value. This concept challenges the dominant view of closed innovation where it is assumed that it is the experts ‘within’ the company that invent and design innovative new products to meet customer needs (Chesbrough, 2006). Shorter innovation cycles, the rising costs of industrial research and development, and a lack of resources have motivated a change in organizational innovation strategies towards a more open approach. OSS is viewed as the most prominent example of the revolutionizing of traditional innovation processes (Gassmann and Enkel, 2006). As Goetz (2003) points out “open source is doing for mass innovation what the assembly line did for mass production”. This fact has prompted a great deal of interest among

researchers in the workings of the open source innovation process. For example, a team led by UNU-MERIT in the Netherlands carried out a study on the economic impact of Free/Libre/OSS (FLOSS) on innovation and the competitiveness of the ICT sector in the EU. In relation to the direct economic impacts of FLOSS, this study found that firms have invested an estimated 1.2 billion euros in developing FLOSS software that is made freely available. Such firms represent at least 565,000 jobs and 263 billion euro in annual revenue. In addition FLOSS directly supports almost 30% of software that is developed in-house in the EU. Some of the indirect economic impacts with FLOSS include industry savings of 36% in software R&D investment that can result in increased profits or that can be more usefully spent in further innovation (FLOSS Report 2006).

Open source software demonstrates two key elements of the open innovation concept – namely the collaborative development of the technology and shared rights to the use of that technology. In its emergent form, OSS represented a community-based software development model where geographically dispersed programmers collaborated to produce software (West and O'Mahony, 2005). However, OSS has since transitioned into the realm of mainstream business and plays an important role in the business models for firms in high technology and other industries (Rajala and Westerlund, 2008; Fitzgerald, 2006). While some research has addressed how OSS business models generate revenue and reduce costs (e.g. Rajala et al., 2006; Krishnamurthy, 2005; Koenig, 2004; Weber, 2004; and Hecker, 2000), the majority of these studies theorise about the possibilities of revenue generation without rigorous empirical data. In addition, revenue generation has been the prime focus of this research, resulting in the value component being neglected. The current literature on value creation and capture with OSS within the open innovation paradigm is also limited, with only one study by West (2007) to date. Indeed, that study was oriented towards IT vendors based in the U.S. despite Chesbrough and Crowther's (2006) assertion that open innovation practices are not limited to 'high-tech' sectors. It has been suggested that the very concept of OSS requires all types of firms to rethink their strategy. In addition, the shift of focus from ownership to one of openness requires a reconsideration of the processes that facilitate value creation and value capture Chesbrough and Appleyard (2007). The emergence of OSS poses a puzzle for conceptions of organisational theory. Our traditional understanding of the organisation has been that individuals organize their productive activities in two ways, either as employees in firms, following directions of managers or as individuals in markets responding to market signals (Coase, 1937). OSS, however, does not rely on markets or traditional managerial hierarchies to organise production (Benkler, 2002). Like open innovation, OSS involves collaboration between firms, suppliers, customers and makers of related products to pool software R&D (West and Gallagher, 2006). The objective of this deliverable is to explore how firms utilising OSS create and capture value. The study begins by describing the results of a theory building process based on analysis of extant research; delineating constructs and the relationship between these constructs in the form of theoretical propositions. We then use two case studies to lend support to our propositions.

2. THEORETICAL FRAMEWORK

Over the years, the most frequently voiced question for firms is how to sustain competitive advantage. More recently, however, this question has transformed into how firms create and capture value. However, little research has directly focused on these fundamental questions in general. Indeed, research has only paid lip service to the notion of value creation, with the vast amount of it focussing on value appropriation for sustainable competitive advantage (Nickerson et al, 2007). While value creation and capture have been identified as two important dimensions of a business model, much of the managerial and academic interest in business models concentrate on how to appropriate value from new Internet-enabled businesses (West, 2007). The process of value creation is also often confused with the process of value capture and it has been argued that both

value creation and value capture should be viewed as distinct processes, since the source that creates value may or may not be able to capture or retain the value in the long term. For example, value created by an organisation, perhaps through the introduction of a new product or process, may not be entirely captured by them but instead may spill over into society as a whole (Lepak et al., 2007). Thus, in order to better understand value creation and value capture with OSS, it is important to examine both concepts. While the current literature on value creation and value capture processes with OSS is sparse, both processes have been touched on using several theoretical perspectives. In this study, we use a process of theory building proposed by Dubin (1969) and Whetten (1989) that consists of analysing extant research and delineating constructs and the relationships between them in the form of theoretical propositions. Specifically, we analyse extant literature on (1) value creation and value capture with OSS and (2) existing theoretical frameworks that review value creation and value capture in general.

2.1 What is Value?

A review of the literature on value reveals a wide array of opinions on the term with no generally accepted definition of it. Surprisingly, little is known about what value is, what its characteristics are, or how consumers determine it. Value has been so loosely defined that people often interchange the term with other concepts such as quality, satisfaction and values (Day et al., 2000). Indeed, researchers have pointed out various distinctions between these concepts. For example, in distinguishing quality from value, Band (1991) states that quality is the means as it can lead to value, but value for the customer is the end result. Similarly, value and satisfaction are distinct in that value derives from the customer's assessment of a service or product's benefits and costs, whereas satisfaction is a reaction to the value actually received from purchase or usage at a given point in time. A further distinction between value and satisfaction is that value can be measured before, during or after consumption whereas satisfaction can only be assessed after consumption (Woodruff and Gardial, 1996; Day et al., 2000). Furthermore, value is a different concept from values in that value refers to a preference judgement whereas values refers to the criteria by which such judgements are made. The value a customer perceives in an item is driven by the values held by that customer (Holbrook, 1994; Day et al., 2000).

Porter (1985) states that value is what buyers are willing to pay, and superior value stems from offering lower prices than rivals for equivalent benefits. Value has been defined variously in the literature as (1) utility based on what is given and what is received (Zeithaml, 1988); (2) perceived benefits relative to the price paid (Monroe, 1990; Bowman and Ambrosini, 2000; Priem, 2007); (3) perceived worth received in exchange for the price paid (Anderson et al., 1993; Bowman and Ambrosini, 2000; Priem, 2007); (4) a customer's perceived preference for product attributes, performances and consequences arising from use that facilitates achieving the customer's goals and purposes (Woodruff, 1997) and (5) a perceived trade-off between the positive and negative consequences of product use (Woodruff and Gardial, 1996). Bowman and Ambrosini discuss the concept of value creation and capture and address questions such as 'what is value?', how is it created?, who captures it?. They provide discussions on what is valuable and the types of value, i.e. use value and exchange value, as well as various theories of value, e.g. the cost of production theories and utility theories. However, they fail to offer a precise definition of 'value'. Brandenburger and Stuart (1996) follow Porter (1980) in defining value as a value chain of players as a whole. Yet again, they fail to offer a definition of value. Similarly, Lepak et al., (2007) argue that the process of creating value is not well understood and that it depends on the relative amount of value that is subjectively realised by a target user who is the focus of value creation. These authors also further discuss the process of value capture. However, both value creation and capture are defined in terms of value, but value itself is not defined (Pitelis, 2008).

The perceptual nature of value is perhaps the most universally accepted aspect of the concept. For example, Pitelis (2008) defines value as the perceived worthiness to a target user of a product or service. This perceived worthiness can be due to rarity, symbolic or aesthetic appeal, a perceived satisfactory price for what is on offer or a combination of these. Such perceived worthiness can be effected through innovativeness, efficiency and effectiveness in the production of a good/service that can lead either to reduced cost and price for given characteristics such as quality or increased differentiation. However, this element of perceived end user value is not fully suitable in the context of open source software. On one end of the scale, value for OSS communities is most often not measured in monetary terms. Rather, they value non-monetary benefits like the fun of coding, the idea of high-quality software, reputation and even honour (Osterloh et al., 2008; Helander and Rissanen, 2005). On the other end, there are potential OSS utilisers that choose OSS over proprietary software for monetary reasons, not ideological ones. Overall, stakeholders in the OSS process are rarely homogeneous in their priorities and so attention needs to be given to value differences for each stakeholder. While the term 'value' is best defined as the perceived worthiness of a product or service to a target user, measuring value in monetary terms in the context of open source is deeply erroneous as money is not always the common denominator of value. In this case, value is best explained as the perceived worthiness of both monetary and non-monetary benefits of the product/service on offer. However, the question of how value is actually created needs to be elaborated on.

2.2 Value Creation

There are two ways to conceptualise the process of value creation– 1) a contingency perspective and 2) a single universal conceptualisation. Researchers such as Bowman and Ambrosini (2000) and Lepak et al. (2005) argue that value creation is a contingency phenomenon and define the process as two types of value - use value and exchange value. It has been suggested that value creation derives from the actions of people in the organisation working on and creating new use values, i.e. specific quality of product etc., as perceived by the customer in relation to the usefulness of the product on offer and the amount they are willing to pay for the product. Organisations will not know what the created use value is worth until it is sold. Exchange value is the monetary amount paid by the customer to the producer for the perceived use value, so exchange value is only realised at the point of sale (Bowman and Ambrosini, 2000). Lepak et al. (2005) also agree with this process but further suggest that value creation will differ based on whether value is created by an individual, an organisation or society. Similarly Priem (2007) argues that value creation involves innovation that establishes or increases the consumer's valuation of the benefits of the product or service. When value is created, the customer either will be willing to pay for a novel benefit; be willing to pay more for something perceived to be better; or will choose to receive a previously available benefit at a lower unit cost.

Value creation is also a universal dimension of recent conceptions of a business model (West, 2007). Indeed definitions provided by Chesbrough and Rosenbloom (2002) and Morris et al. (2005) propose that value creation necessitates identifying a relevant customer segment, the value proposition for each and how the business model will provide that value. This definition is a popular choice in research carried out on value creation with open innovation strategies. Indeed this concept is evidenced in West's (2007) study of OSS business models in IT vendor firms where it was found that the relevant customer segment for open source has largely been business buyers. The value proposition with OSS was the lower costs and less lock-in compared to proprietary software. In addition, as business buyers expect a richer whole product solution such as integration, customisation, integration, support etc., this creates more opportunity for vendors to combine priced and unpriced complementary assets that create value (West, 2007). Complementary assets, or complementarities as Amit and Zott (2001) call them, are those assets, i.e. resources, capabilities,

know-how, goods or services that surround the successful commercialization of an innovation (Teece, 1986; Dodgson et al., 2008). For many innovations, complementary goods or services are vital for completing the whole product approach demanded by customers. Customers value ‘bundled’ complementary goods when their costs are lower than when they are delivered separately or when the performance of the bundle is better than when customers have to bundle the products themselves (Vanhaverbeke, 2008). However, such complementary assets are often to be found in a value network (West, 2007). In addition, Shafer et al. (2005) agree that value creation is a core element of a business model and argue that successful firms create substantial value by doing things that differentiate them from the competition. They might develop core competencies, capabilities etc. that are different from competitors and use these to perform work activities in a unique way. Traditionally, however, the value proposition has been created with only one target audience in mind: the customer. However, in the open innovation and OSS context, there are many stakeholders, e.g. suppliers, customers, third-parties, OSS communities etc., and so the value proposition will be different for each. In order to satisfy different needs, there may be several value propositions, some that are monetary and others non-monetary.

Thus, while the common definition offered by West (2007), Morris et al. (2005), Shafer (2005) etc., is a suitable one for this study, it contains some shortcomings in that it focuses largely on value created for the customer only. However, it would be remiss to believe that the customer is the sole target of value creation as there are many other potential targets for value creation, e.g. employees, shareholders, wider society etc. (Lepak et al. 2007). Moran and Ghoshal (1996) also agree with this and suggest that “the more value a firm creates, the more likely it is to benefit from some of that value in the form of appropriable, if transient, rents. And what the innovator does not get in rents, society gets in progress” (p. 2). In addition, various stakeholders will have different perspectives as to what is valuable, i.e. monetary and non-monetary benefits, and so the value created will be evaluated in different ways (Lepak et al., 2007). Thus, the following definition was adopted for use in this study: Value creation entails identifying key stakeholders, eliciting their perspectives on the perceived worthiness of the product/service on offer, creating the value proposition for each and determining how the business model will deliver that value.

2.3 Traditional Approaches to Value Creation

2.3.1 Transaction Cost Economics

The concept of transaction cost economics (TCE), first introduced by Coase in the late 1930s as a first attempt to explain why firms exist (cf. Coase 1937) and later extended and developed by Williamson (1981), is essentially a single company oriented analysis of cost minimization where transaction efficiency is identified as a major source of value, i.e., enhanced efficiency reduces costs. This theory emphasizes that companies choose for their economic exchange arm-length transactions, hierarchical control or intermediate governance modes, e.g. joint ventures, strategic alliances etc. in order to reduce transaction costs (Vanhaverbeke et al., 2007). Furthermore, organizations that economise on transaction costs can be expected to extract more value from transactions (Amit and Zott, 2001). While market transactions are usually highly efficient as transaction governance mode, other parties often have the incentive to behave opportunistically. If this happens, however, companies can mitigate the risk by choosing a hierarchical governance mode such as acquiring the economic exchange partner (Vanhaverbeke et al., 2007).

However, one of the limitations of this theory is its stringent focus on transactions and the view of the boundaries between market and hierarchy (Rajala and Westerlund, 2005). As already mentioned, OSS projects do not rely either on markets or on managerial hierarchies to organise

production. While research on open source through a TCE lens is in its infancy (Niederman et al., 2006) it has also been found that the emphasis of transaction cost economics on efficiency may divert attention from other important sources of value such as innovation and the reconfiguration of resources (Ghoshal and Moran, 1996). In addition, TCE's focus on cost minimisation and neglects innovation (Lazonick, 1993) and the mutual relationship between exchange parties and the opportunities for value creation that this presents (Amit and Zott, 2001). It has also been found that partners in open innovation are not interested in transaction cost minimisation (Vanhaverbeke et al., 2007); in the pursuit of transactional value they will choose cooperative and collaborative modes with higher transaction costs, as long as eventual joint gains prevail over transaction costs (Zajac and Olson, 1993). Opportunistic behaviour also tends to be suppressed by the fact that companies are continuously establishing non-arm length transactions with innovative partners and any tendency to behave opportunistically is dominated by the firm's reckoning of the negative impact this behaviour will have on valuable future exchanges with its partners (cf. Vanhaverbeke et al., 2007).

2.3.2 *Value Chain Analysis*

Porter's (1985) value chain framework analyses value creation at the firm level and addresses the activities a firm should perform. It also examines the configuration of the firm's primary and support activities that would enable it to add value to the product and to compete in its industry. The goal of these activities is to create value that exceeds the cost of providing the product/service. Porter suggests that in order for a company to deliver customer value and satisfaction, they must manage the value chain. Value can be created through differentiation along every step of the chain resulting in products and services that lower buyers' costs or raise buyers' performance. However, this type of framework was found to be more suitable to describing and understanding value creation in a traditional production and manufacturing company and less so in service industries where the resulting chain does not fully capture the real meaning of value creation (Stabell and Fjeldstad, 1998). In addition, this framework focuses on value creation as a linked chain of activities; a perspective that leads to the development of strategies that concentrate on controlling this chain (Peppard & Rylander, 2006). Thus, Prahalad and Ramaswamy (2001) argue that while the concept of the value chain has served managers well in the industrial age, it is time to question this dominant logic of value creation that pervades the mindset of firms. For example, this logic has a company-centric view written all over it for a number of reasons, most notably: (1) in this view, consumers are outside the domain of the value chain (2) it is the enterprise that controls where, when and how value is added in the activities of the value chain, (3) value is created as a series of activities influenced by the firm before the point of exchange and (4) exchange is viewed as a process of value extraction or appropriation for the enterprise.

Porter (1985) further argues that a firm's value chain links to the value chain of both suppliers and of buyers of products and services, resulting in a large stream of activities called the value system. However, there is a major distinction between value creation in the open innovation and open source context and within the classical value system. For example, while every company in the classical value system occupies a particular position within the system and adds value to inputs before passing them on to the next actor in the chain, relationships between these actors (e.g. suppliers, substitutes, etc.) can be described as simple exchange relations, mainly dealt with by means of arms-length transactions. As Vanhaverbeke et al. (2007, p.5) point out, "managing and organising requirements are restricted to activities within the firms. There is a clear distinction between firms and markets; outside the firm boundaries only markets exist". Additionally, in open innovation, firms jointly create value through a number of non arm-length transactions in value networks (Vanhaverbeke et al. 2007).

2.3.3 *Knowledge-Based View of the Firm*

In contrast to the Porterian model and TCE-based theory, the knowledge-based view treats knowledge as a key resource underlying value creation (Grant, 1997). Originating from the strategic management literature, the knowledge-based view of the firm (KBV) has largely extended that of the resource-based view (RBV) of the firm (see section 2.4.4). While RBV tends to focus on value appropriation (Kapler, 2007), the KBV treats knowledge assets as a strategic competitive advantage and strategy of the firm. Kang et al. (2007) suggests that a firm's success rests on its ability to offer new and superior customer value, which in turn relies on its ability to explore and exploit employee knowledge that can become the basis for significant innovations that create value for targeted customers. In addition, a knowledge-based perspective suggests that organizations that have superior knowledge resources are able to coordinate and combine their traditional resources and capabilities in new and distinctive ways (Teece et al., 1997). However, the existing literature on KBV has some significant shortcomings. For example, this approach has been criticised for its lack of empirical literature. Indeed Eisenhardt and Santos (2002) point out that while KBV as a theory of strategy rests on the assumption that knowledge is the most important resource, there appears to be very little empirical evidence to substantiate this. In addition, many of the perspectives on KBV are quite static in that they see the control and protection of knowledge as the basis for sustainable competitive advantage because it is the most difficult to imitate (Eisenhardt & Santos, 2002; McEvily & Chakravarthy, 2002; Liebeskind, 1996). In other words, the dominant view is how best a firm can accumulate, apply, integrate and protect knowledge inside a firm. From an open source and open innovation perspective, a firm's knowledge should extend beyond its boundaries and enable knowledge flows with other firms. When a firm increases its internal knowledge base by bringing in external knowledge, it can use this new knowledge to generate new innovations (Vanhaverbeke et al., 2007).

2.3.4 *Dynamic Capabilities*

Dynamic capabilities is another body of literature in the field of strategic management concerned with examining how organizations create value by developing new capabilities and competencies in a dynamic environment (Teece et al., 1997). According to Teece et al., (1997, p. 515) "winners in the global marketplace have been firms that can demonstrate timely responsiveness and rapid flexible product innovation, coupled with management capability to effectively coordinate and deploy internal and external competencies". Dynamic capabilities are those organizational and strategic routines that lead managers to alter their resource base, i.e. obtain and shed resources, integrate them together and recombine them, to generate new value-creating strategies (Eisenhardt and Martin, 2000; Grant, 1997; Pisano, 1994). However, some researchers remain sceptical about the nature and role of dynamic capabilities. It has been argued that few empirical studies have engaged in defining, operationalising and measuring the impact of dynamic capabilities on firm performance. (Protogerou et al., 2005). Thus, the "emergent literature on dynamic capabilities and their role in value creation is riddled with inconsistencies, overlapping definitions, and outright contradictions" (Zahra et al., 2006, p. 918).

2.3.5 *Schumpeterian Innovation*

In Schumpeter's (1934) theory, innovation is the source of value creation. Schumpeterian innovation emphasizes the importance of technology and considers novel combinations of resources and the services they provide as the foundation of new production methods, which in turn lead to the transformation of markets and industries (Amit and Zott, 2001). However, open innovation and OSS broaden this idea of innovation since these models spans firm and industry boundaries,

involving new methods of exchange and collaborative development, rather than simply new production processes.

2.3 The Importance of a Value Network for Value Creation

The above frameworks have some shortcomings in examining value creation with OSS. For example, models like transaction cost economics and the value chain framework do not account for the nature of alliances, competitors, complementors and other members in partner networks or value networks as they are more commonly termed (Peppard and Rylander, 2006). OSS and open innovation differ from the TCE approach in that TCE focuses on minimising costs in order to create value, rather than maximising value through cooperative modes in networks. In addition, the knowledge-based view of the firm focuses on knowledge that is controlled within the firm while OSS and open innovation is concerned with combining and exchanging knowledge in value networks. Value networks are key conduits through which knowledge flows from the environment to the firm and vice versa (Simard and West, 2008). Indeed, they are viewed as vehicles for producing, synthesising and distributing ideas and increasingly the success of a firm is linked to the depth of their ties to network partners. Value networks constitute four dimensions – value creation, transactions, the combination of resources and capabilities of different partners and finally networking. However, they have to be considered jointly to understand the process of value creation and cannot be sufficiently addressed by theoretical frameworks that only address one of these dimensions (Vanhaverbeke and Cloudt, 2008), such as those listed in Section 2.2 above which neglect the importance of combining the resources/capabilities of various partners outside the firm and networking. Value networks are entities consisting of several connected individuals or organisational actors that transform and transfer various resources in order to create value not only for the network's end customer but also for themselves (Helander and Rissanen, 2006). A network offers the firm the potential to share risk, generate economies of scale (Katz and Shapiro, 1985; Shapiro and Varian, 1999), share knowledge and facilitate learning (Dyer and Nobeoka, 2000; Dyer and Singh, 1998). In other words, networks provide firms with opportune access to knowledge and resources that are otherwise unavailable, while also testing internal expertise and learning capabilities (Powell, 1998). When these networks work, they allow firms to create value that no single firm could have created alone (Adner, 2006). Indeed, value networks are characterised by multi-directional relationships, a value web rather than a value chain. Monetary and non-monetary relationships are closely interconnected, complementary and equally important. Non-monetary relationships bring advantages which are not necessarily immediately reflected on the bottom line; these are what economists call network externalities. Network externalities benefit the ecosystems or value networks as, by reinforcing its attractiveness, they reinforce its sustainability and they may also benefit individual firms since in value networks the real winners are those organizations which can leverage network externalities. Whereas value chains are essentially defined by the accumulated value generated by monetary relationships, value networks are also defined by the non-monetary advantages derived by firms participating in them. Therefore, a value network growth depends to a large extent on the quality of the non-monetary, qualitative interactions between stakeholders (Thomas, 2008).

In a value network environment, organizations focus not on the firm or industry, but on the value-creating system itself, which includes suppliers, partners, allies and customers and other network players working together. The firm focuses on creating value, where value is determined by the resources and capabilities assembled and combined by different partners and how well they perform joint tasks (Vanhaverbeke and Cloudt, 2008; Hamel, 1991). West (2007) also highlights the importance of competitors in a firm's value network, as these competitors often collaborate to further develop or stimulate adoption of a shared technology. For example, Nokia and Sony Ericsson are two such competitors that collaborate in a value network, i.e. the open source Eclipse

foundation, to simplify mobile development. Gaining entry to a network enables firms to address a specific knowledge need quickly, without having to spend an astronomical amount of time and money developing that knowledge internally or acquiring it through vertical integration (Simard and West, 2008). In addition, cooperation between firms increases knowledge gain and reduces the waste of repeated effort (Teece, 1989). Access to complementary skills and a broader knowledge-base that facilitates different types of knowledge exchange in a network positively influences firm innovation (Simard and West, 2008). Additionally, substantial knowledge exchange in a network leads to value creation as it facilitates joint learning, fosters problem-solving, and the integration of complementary resources enables joint creation of products, technologies and services (Parise and Henderson, 2001). Such knowledge is not limited to technical knowledge and may include knowledge from customers, market segments, partners etc. that is deemed necessary for the commercialisation of an innovation (Simard and West, 2008).

In the context of OSS, Dahlander (2004) proposes that in addition to inter-organisational relations, relationships between the firm and the OSS community (users and developers) are equally important. It has been argued that innovation is positively influenced by a firm's access to complementary skills and a broad knowledge-base that facilitates different types of knowledge exchange in a network context (Simard and West, 2006). In addition, substantial knowledge exchange in a network leads to value creation as it facilitates joint learning, fosters problem-solving, and the integration of complementary resources enables joint creation of products, technologies and services (Parise and Henderson, 2001). Companies develop relationships with universities, research laboratories etc., to explore the technical and commercial value of new technologies and some also set up networks with suppliers and customers in order to launch new products or services based on new technologies or a new business model (Vanhaverbeke, 2008). Open innovation also increases the significance of intra-organisational networks (West et al., 2006). Indeed, the effective management of externally acquired knowledge will most likely require the development of complementary internal networks (West et al., 2006; Hansen and Nohria, 2004). In contrast, the implications that open innovation has within an organisation and in particular the fact that it affects different parts of an organisation differently are largely neglected in the current literature (Alexy and Henkel 2009).

It has been found that the degree of value creation from an OSS value network depends on (a) the number of adopters that attract suppliers of complementary goods and services and (b) the number of third parties that are qualified to contribute core or complementary technologies and are willing to do so. These may be complements that are integrated and sold as a whole product or complements that are sold or given away separately, thus increasing the value of the core innovation, as with the numerous projects created at SugarForge.org, an open source website hosted by SugarCRM, an OSS vendor (West, 2007). Learning how to create value when companies are highly reliant on each other in a value network, however, is an underexplored area in the literature. For the majority of companies, decisions are usually made within the boundaries of the firm and the external environment viewed as an arena where firms compete with one another (Vanhaverbeke, 2008). This is apparent in most firms utilising OSS. The software is basically treated the same as any other third-party software and typically only one-way interaction between the firm and the environment takes place, resulting in clear distinct boundaries between the two (Alexy and Henkel, 2009). In a value network, value is co-created or co-produced. Thus, companies with complementary capabilities have to be fully committed to cooperate in the value network. As Vanhaverbeke (2008, p. 218) suggest, "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". Therefore, the value a firm creates from being part of a network depends on how well partners' objectives are aligned to each other and on partners' commitment to invest in complementary assets (Teece, 1986; Moore, 1991).

Successfully ensuring alignment of objectives and partners' commitment, however, relies on two important issues. First, the firm has to structure and manage the value network so that the potential of the network to create joint value is maximised. Secondly, it has to make agreements with network participants to share this jointly created value (Vanhaverbeke and Cloodt, 2008). Thus, resources and capabilities of network actors have to be effectively combined and governed at the network level. Trust, leadership and a unifying vision play an important role in bringing disparate partners together in a network and the absence of internal competition among participants in the network is crucial (Gomes-Casseres, 2003). Thus, the firm will have to actively nurture the value network to manage potential tensions or conflict between participants. Additionally, the firm has to make a number of arrangements with other participants to stick to the network, e.g. offer incentives such as access to information and knowledge, compensation etc. (Vanhaverbeke and Cloodt, 2008).

2.4 Value Capture

It is frequently argued that the primary objective for firms is to maximise the returns from the resources a firm possesses over time (Dahlander, 2005; Barney, 1991). In order for firms to succeed, it must be able to capture the value created in the form of economic profits (producer surplus). Producer surplus is the difference between the price charged for the good and the incurred costs (Enders et al., 2004). Possible ways of protecting knowledge and thereby appropriating future returns influence the firms' incentive to induce investments in strategic innovation (Liebeskind, 1996). Value capture or appropriability is defined as the possibility the owner of a resource has to capture a return equal to more than the value created by that resource. The appropriability regime governs an innovator's ability to capture the profits generated by an innovation (Dahlander, 2005; Teece, 1986). Comparable to the concept of value creation, the value capture process has also been conceptualised from both a contingency and universal perspective. In relation to the contingency perspective, it has been suggested that the capture of value, a realisation of exchange value, is a function of a bargaining process between the actors involved, i.e. buyers and sellers (Bowman and Swart, 2006; Bowman and Ambrosini, 2000; and Brandenburger and Stuart, 1996). The customer's bargaining power is enhanced by the presence of close substitutes, combined with low switching costs, which in turn reduces the buyer's ability to capture exchange value in the form of high prices. Profit is value captured by the firm. It has also been found that players with high added value are the ones who may appropriate value since their bargaining power is high while players with low added value will not capture any (Brandenburger and Stuart, 1996). The size of the pie captured by a firm depends on factors such as market power, enabled through structural barriers to entry as pointed out by Bain (1956) and Porter (1980) and on the ability of a firm to create differentiation in comparison with their competitors (Porter, 1985).

In addition, Lepak et al. (2007) point out that value capture varies, depending on the particular source, i.e. individual, organisation or society, that directs the process and the level of competition and isolating mechanisms surrounding the value that is created. As increments in the novelty and appropriateness of a product or service increase, the use value and monetary exchange value will also increase. The creation of appropriate and new products or services will often yield a situation where there is limited supply and high demand. Thus, competition ensues as other suppliers seek to replicate the new value created and participate in the profit. Consequently, exchange value (price) will decline to the point where supply equates demand. The existence of an isolating mechanism (i.e. knowledge, physical or legal barriers that prevent replication of the product/service by a competitor) raises the potential bargaining power of the creator of value to retain this value. (Lepak et al., 2007).

Value capture is also viewed as another important element of a business model (West, 2007; Shafer

et al., 2005; Chesbrough and Rosenbloom, 2002) and explains how a firm captures value from its value creation in order to sustain the business model (West 2007; Feeney 2006; and Dahlander, 2004). Some of the key steps in formulating a value capture strategy are defining a revenue model, including what will be priced and how much will be charged (Amit and Zott, 2001); ensuring the cost structure is consistent with the customer's perceived value and the portion that will be captured (Chesbrough and Rosenbloom, 2003) and also firms must establish durable external relationships with customers and third parties in a value network (West, 2007; Stabell and Fjelstad, 1998). In his study of value capture in OSS business models, West (2007) found that OSS has a lower appropriability, and thus reduced value capture, than proprietary software because the source code is available for reuse and modification by competitors, customers and complementors. Therefore, the revenue model centres on the sale of complementary goods and services to complete the whole product solution. In terms of establishing durable external relationships, firms make source code open in the hope of attracting external contributions from third parties and competitors. Other value capture strategies with OSS include non-monetary gains such as access to superior technical knowledge and an excellent reputation useful in marketing. Complementary assets play an important role in capturing value from an innovation and so the innovator must entice third-party suppliers of these complementarities to complete the innovation. This finding by West (2007) follows that of Teece (1986) who argued that an outstanding innovation is not a guarantee of successful commercialization. Instead the process requires access to complementary assets that will increase the likely probability of successful commercialisation. Yet again, a firm's position in a value network of potential complementors determines the value captured (West, 2007).

Therefore, while the definition provided for by West (2007), Shafer et al. (2005) and Chesbrough and Rosenbloom (2002), is an appropriate one for this study, value capture with OSS needs to be considered in non-monetary terms as well as monetary terms. The notion of other benefits besides those of monetary value is important in the OSS context as money may not be the prime motivator. Instead, the capture of non-monetary benefits like access to high quality software, superior technical knowledge and human resources outside the firm may be considered just as significant. Thus, the following definition is put forth for this study: value capture is the possibility of the firm and network participants to appropriate monetary and non-monetary value from its value creation to sustain the business model.

2.5 Traditional Approaches to Value Capture

2.5.1 Neoclassical Theory

Traditional neoclassical theory focuses on value captured in the form of monopoly rents (Lazonick, 1993, Moran and Ghoshal, 1996; Pitelis, 2002). A typical neoclassical firm controls the transformation of inputs (resources it owns) into outputs (sale of products) and earns the difference between what it receives in revenue and what it spends on inputs. In this theory, firms compete based on price but as Baumol (2002) argues, innovation rather than price is the primary competitive dimension and less innovative firms will find their markets shrinking as they lose business to more innovative competitors. It has also been argued that this theory views the firm as essentially a perfectly efficient 'black box' concerned with maximising profits and has nothing to say about the internal organisation of the firm or innovation for that matter (Hart, 1995; Teece, 1986). Thus, OSS innovation is not easily explained in neoclassical economic terms. The production of goods in a neoclassical firm includes a formal division of labour that uses proprietary knowledge, is guarded by restrictive IPR and managed 'within' a hierarchy that guides and governs the process. In contrast, OSS production and distribution is practically based on the absence of a hierarchy and is fundamentally about cooperation and collaboration. For example, collaborative OSS projects such as Linux and Apache have demonstrated empirically how the production process takes place in a

voluntary community-based setting with developers working in a highly parallel, relatively unstructured way and without direct monetary compensation (Weber, 2004).

2.5.2 *Industrial Organisational Theory*

Industrial organisational theory of the 1950s and 1960s is useful in determining the likely profitability of an industry and in turn the value appropriated by firms (Porter, 1981). The firm in traditional industrial economics focuses on market structure. In this approach, exogenous demand and supply conditions determine industry structure, which in turn determines the conduct of firms, and performance depends upon various properties of the industry including the degree of concentration, barriers to entry, product differentiation and the presence of scale economies (Porter, 1981; Seth and Thomas, 1994). However, it has been argued that this view is characterised by the same black box metaphor as the neoclassical approach, treating the firm as a product of deterministic forces and ignoring inter-firm differences (Seth and Thomas, 1994). In addition, this view has been criticised for its preoccupation with value captured in the form of monopoly rents as the basis for explaining and predicting firm performance (Moran and Ghoshal, 1996; Pitelis, 2002). Yet again, open innovation and OSS suggest activities that are the opposite extreme of this theory. Open source software is not about erecting barriers to entry and excluding potential rivals. Rather, OSS promotes anti-rivalry and inclusiveness. These two dimensions result in positive network externalities where cooperation between contributors becomes the rule, not the exception (Cooper, 2005).

2.5.3 *Value Chain Analysis*

The concept of value chain analysis has focused on ways in which firms may configure their primary and support activities to maximize and sustain competitive advantage (Porter, 1985). The goal of these activities is to create value that exceeds the cost of providing the product/service, thus generating a profit margin. In order for a company to deliver customer value and satisfaction they must manage the value chain. According to Porter, 'value is measured by total revenue...a firm is profitable if the value it commands exceeds the costs involved in creating the product' (1985:38). However, as with value creation, the value chain model appears to be more suited to describing and analyzing a traditional manufacturing firm and less suited to the analysis of activities in service industries (Stabell and Fjeldstad, 1998). In addition, the value chain analysis is an incomplete instrument for analyzing value capture with OSS since it does not span firm boundaries and value capture is measured solely in monetary terms. Contributors to OSS also value non-monetary gains such as recognition, access to code and technical knowledge.

2.5.4 *Resource-Based View of the Firm*

The resource-based view (RBV) of the firm is also concerned with questions of value appropriation and sustainability of competitive advantage (e.g. Barney, 1997). This view conceptualizes the enterprise as a bundle of resources and capabilities. In order to create and sustain competitive advantage and capture above-normal rates of returns, these resources must be scarce, valuable and reasonably durable (Barney, 1997). According to Barney (1997, p. 147), a firm's resources and capabilities are "valuable if, and only if, they reduce a firm's costs or increase its revenues compared to what would have been the case if the firm did not possess those resources". In addition, the RBV places greater emphasis on the prevention of other firms from appropriating the firm's own existing rent streams (Moran and Ghoshal, 1996). Thus, the capacity of firms to obtain rents from their activities does not depend on the product/market chosen but rather on the system of resources firms possess or control and the way in which these are combined to carry out the productive process that enable it to offer particular products/services on the market (Destri and

Dagnino, 2005).

Furthermore, proponents of the resource-based view emphasize that a sustainable competitive advantage is based on those resources and capabilities that are owned and controlled 'within' the boundaries of a single firm (Dyer and Singh, 1998). However, despite the significance of this perspective, RBV has not gone unchallenged. For example, this approach has been criticised for its lack of empirical grounding (e.g. Enders, 2004; Williamson, 1999; Miller and Shamsie, 1996; Michalisin et al., 1997; Priem and Butler, 2000). It has been argued that studies that concentrate on RBV only provide little empirical evidence through singular case studies while studies that are based on a larger scale only touch on the resource-based view in passing (Enders, 2004). In addition, it has been called conceptually vague and tautological, with little attention to the means by which resources actually contribute to competitive advantage (e.g. Eisenhardt and Martin, 2000; Mosakowski and McKelvey, 1997; Priem and Butler, 2000; Williamson, 1999). Another deficiency in the RBV approach is that it neglects the environment (Foss, 1997) or fails to specify the context within which it is supposed to hold (Priem et al., 2001a). From an OSS and open innovation perspective, however, resources should not be closed off within one single firm. Rather, durable, valuable and scarce resources of different firms should be combined in order to capture value (Vanhaverbeke, et al., 2007).

2.6 The Importance of a Value Network for Value Capture

It is evident that the above theoretical frameworks for value capture are based upon ownership and control as the key levers in achieving strategic success and aim to protect, rather than share, valuable resources and capabilities that are housed within the firm. All focus largely within the firm and take no notice of the potential value of external resources (such as those of a partner or value network) that are not owned by the firm in question (Chesbrough and Appleyard, 2007). From the OSS and open innovation perspective, resources should not be closed off within one single firm. Rather, durable, valuable and scarce resources of different firms should be combined in order to capture value (Vanhaverbeke, et al., 2007). While Porter's value-chain analysis may be somewhat valuable in examining open innovation and value networks, value is determined by the performance of individual partners, not by the cohesion and structure of the network as a whole (Vanhaverbeke and Cloudt, 2008). Additionally, while the RBV stresses issues like independence and the role of competition between firms based on the unique resources and capabilities it possesses, in contrast OSS and open innovation emphasise the interdependence of complementary resources of firms in a value network in order to introduce a new innovation to the market (Vanhaverbeke et al., 2007). As with value creation, the value network created around a business shapes the role that suppliers, customers and third parties play in influencing the value captured from commercialization of an innovation (Chesbrough and Rosenbloom, 2002). In an OSS value network, firms often gain a large pool of users and third-party complementors to increase the value of their product/service. Users often reveal their internal complements for use by others because they may not be able to capture value from minor improvements, or because they gain other benefits from the disclosure, e.g. recognition. On such example is the contribution of foreign language translations as is the case of Zend with PHP and Sun Microsystems with OpenOffice (West, 2007).

In a value network, value capture has to be considered jointly with the value creation strategy because in both cases the commitment of the participants, the alignment of their objectives, and the exchange of knowledge among them, determine the amount of value captured (Vanhaverbeke and Cloudt, 2008). As Peppard and Rylander (2006) argue, the flow of knowledge and other resources in the network is vital for its sustainability. Firms can capture value by developing superior knowledge-sharing routines with partners in the network. This, however, is dependent on

incentives that encourage partners to be transparent, to transfer knowledge and prevent free riding on the knowledge acquired from the partner (Dyer and Singh, 1998). In addition, each participant should capture some value from its contribution to the network. Two factors determine the strength of the value network: the extra value created in comparison with competing value systems, and the commitment of the different participants in the network. It has been further suggested that each participant reap some benefits to ensure that one stays committed. Fair distribution of value in a network is also important because while some participants are automatically better off in the network, others might be worse off and have to receive some return in order to stay committed to the value network. Thus, the value captured in a network depends on how well participant resources are combined and managed within the network. In order to optimise value capture, a firm will have to orchestrate the network partners, lead and nurture them while minimising any potential tensions and instilling a unifying vision (Vanhaverbeke and Cloudt, 2008).

2.7 Preliminary Model

Each theoretical framework outlined above makes valuable suggestions about possible sources of value creation and value capture. Certainly each framework has been useful in presenting constructs for use in this deliverable. Nevertheless, the various theoretical frameworks have some limitations when applied in the context of open source software and do not provide a complete picture in explaining value creation and value capture (see Table 1.0). Traditionally, strategists use linear models like the value chain to analyse the firm and its major competitors and to identify gaps between firm performance and a competitor's performance. Once the gaps are realised, the strategist can create and implement plans to close them. However, models like Porter's value chain framework and the resource-based view of the firm are largely introspective and do not account for the nature of alliances, competitors, complementors and other members in value networks (Peppard and Rylander, 2006). Indeed based on the research carried out in the previous two sections, it is apparent that access to a value network of potential complementors is critical to a firm's ability to create and capture value with OSS. Additionally, to enable successful value creation and capture, firms with complementary resources/capabilities or positions in the network must be fully committed to cooperating with each other. Superior knowledge exchange in a network that encourages transparency and prevents free-riding on the knowledge gained also facilitates successful creation and capture of value. Given the potentially diverse interests and motivations of the players in a value network, a firm needs to align their objectives with those of the entire network so that each acts in the best interest of the network and value creation and capture is maximised. In addition, a firm has to effectively combine and govern the resources and capabilities in the network to optimise the value created and captured with OSS. Based on the constructs identified, we can delineate three propositions:

Proposition 1: Being part of a value network of potential complementors is critical to the ability of a firm to create and capture value with OSS.

Proposition 2: The greater the level of commitment, volume of knowledge exchange and alignment of objectives, the greater the potential for firms to create and capture value with OSS.

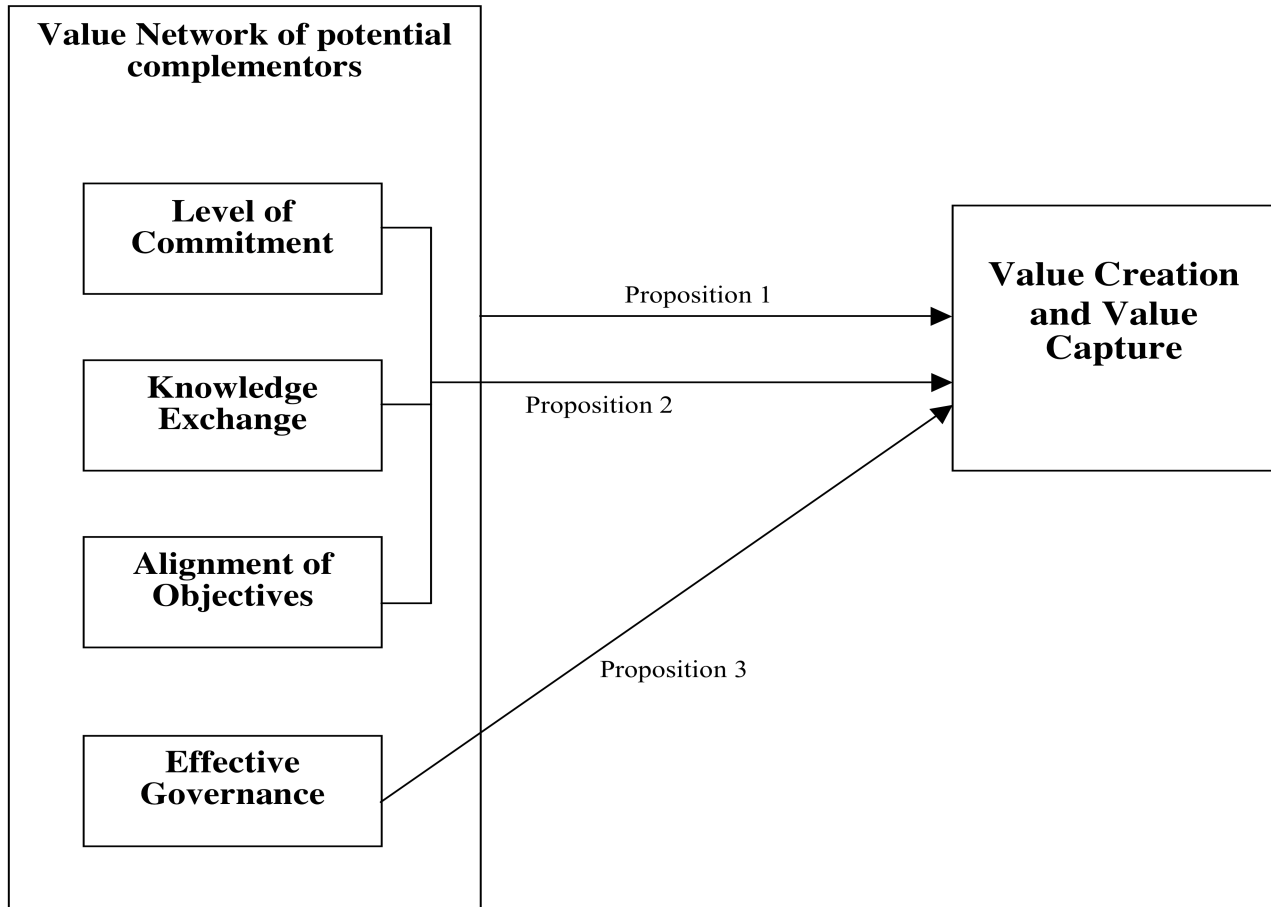
Proposition 3: A firm's ability to effectively combine and govern resources and capabilities in the value network will facilitate greater value creation and capture with OSS.

Theoretical Framework	Pros	Limitations
<i>Value Creation</i>		
Value System/Value Chain	Concentrates on primary and support activities that have direct impact on value creation	Managing and organising requirements restricted to activities within the firm. Outside the firms' boundaries, only markets exist. No real emphasis on joint value creation with suppliers, customers etc within the value network. More suited to manufacturing firms than service industries
Transaction Cost Economics (TOE)	Identifies transaction efficiency as a major source of value, as enhanced efficiency reduces costs	May redirect attention from other important sources of value such as innovation and the reconfiguration of resources. Also focuses on cost minimisation and neglects interdependence between exchange parties and the opportunities for value creation that this presents
Dynamic Capabilities	Concentrates on development and renewal of resources/capabilities that deliver competitive advantage (Teece et al., 1997)	Largely reactive perspective. Existing literature riddled with inconsistencies
Knowledge-Based View (KBV)	Knowledge is a key resource. Organisations that have superior knowledge can combine traditional resources/capabilities in new and distinctive ways	Static perspective. Dominant view is how best to control and protect knowledge inside a firm
Schumpeterian Innovation	Innovation is source of value creation – foundation of new production methods and transformation of markets	Concentrates on new production methods rather than new methods of exchange and collaboration
<i>Value Capture</i>		
Neoclassical Theory	Focuses on value captured in the form of monopoly rents	Has nothing to say about innovation or the internal organization of the firm.
Industrial Organisation Theory	Useful in determining how firms maximize profits through erection of barriers to entry, product differentiation etc.	Pre-occupied with value captured in the form of monopoly rents.
Value Chain	Focuses on ways in which firms may configure their primary and support activities to maximize and sustain competitive advantage	More suited to describing and analyzing activities for sustaining competitive advantage in traditional manufacturing firm and less suited to the analysis of activities in service industries
Resource Based View (RBV)	Concerned with maximizing rents from the resources a firm possesses over time	Largely introspective - based on resources and capabilities that are owned and controlled within the boundaries of a firm

Table 1.0. Theoretical Views in Relation to Value Creation and Value Capture

We now conclude this process of building a preliminary model by presenting the constructs and the proposed relationships between them (as Proposition 1, 2 and 3) in Figure 1.

Figure 1. Theoretical Model of Constructs and Relationships



3. RESEARCH METHODOLOGY

This deliverable constituted a post-positivist methodological approach and sought to ‘approximate reality’ (Guba, 1990) using methods that emphasize the verification of existing knowledge and the discovery of new knowledge (Denzin and Lincoln, 2000). While the positivist epistemology deals only with observed and measured knowledge, the post-positivist epistemology recognizes that such an approach would result in making many important aspects of psychology irrelevant because feelings and perceptions cannot be readily measured. In post-positivist understanding, pure empiricism, i.e., deriving knowledge only through observation and measurement, is understood to be too demanding or even impossible. Instead, post-positivism is based on the notion of critical realism, that there is a real world out there independent of our perception of it and that the objective of science is to try and understand it. The post-positivist epistemology regards the attainment of knowledge as a process that is more than mere assumption. Knowledge is acquired through both deduction and induction (Straub et al., 2004). Given the scarcity of empirical work in the area of value creation and capture based on OSS and open innovation, and the need to obtain rich data, the study was considered exploratory in nature and thus, a case study research strategy was considered most appropriate. The two case studies comprised a supplier of medical equipment and devices and a telecommunications provider. At the outset, it was evident that value creation and capture would be distinctly different in these two environments. The supplier of medical systems have leveraged

open source principles for the development of a medical imaging platform while the telecommunications provider currently use OSS as part of their commercial solutions to over 18 million residential and commercial customers. We therefore needed a data gathering and analysis approach that allowed us to test our propositions in a manner that was both theoretically consistent and sensitive to the strategic and operational activities necessary for value creation and capture in the case study sites.

The researchers prepared a case study protocol (cf. Yin, 1994) and data was gathered over a four-month period. Data gathering techniques included face-to-face interviews and telephone interviews (see Table 3), which were tape-recorded and transcribed. A copy of the transcript was sent to each of the interviewees afterwards for validation purposes. The choice of interviewees was based on (a) their willingness to cooperate, (b) the company's history of engagement with OSS and (b) their history of network involvement and/or project activity over a period of time. Interviews, conducted using an interview guide (cf. Patton, 1980) were generally of one to two hour duration, with follow-up telephone interviews used to clarify and refine issues that emerged during transcription. The content analysis was conducted using Osterwalder and Pigneur's (2002) business model framework (see Table 2). This ontology builds on and integrates ideas advocated by the traditional theoretical frameworks outlined in this paper. Firstly, it draws on Porter's value chain analysis, by concentrating on the importance of configuring activities and processes for value creation and capture. It also builds on the theory of transaction cost economics as it looks at the relationship between participants in the business venture, focusing on aspects such as the transactional elements involved in the interaction between firm and client. This ontology is also consistent with Schumpeter's innovation theory in that it is concerned with sources of innovation such as new product offerings, distribution channels and creation of new markets. In addition, it also considers the core competencies, i.e. unique resources and capabilities, that firms need to possess in order to create and capture value, and thus is consistent with the dynamic capabilities and resource-based view of the firm. This business model concept is also concerned with storing, mapping and externalising knowledge about the value creation logic of a firm (Osterwalder et al., 2005) and has a lot in common with the knowledge-based view of the firm. However, one important building block that is embedded in this ontology is that of a partner network, an element that is lacking in the existing theoretical approaches and something that is deemed extremely important for this study. In addition, this business model ontology considers jointly all four dimensions as recommended by Vanhaverbeke and Cloudt (2008), namely value creation, transactions, the combination of resources and capabilities and finally networking.

Table 2. Nine Business Model Building Blocks (Source: Osterwalder et al., 2005)

Pillar	Business Model Building Block	Description
Product	Value Proposition	Gives an overall view of a company's bundle of services and products
Customer Interface	Target Customer	Describes the segment of customers the company wants to offer value to
	Distribution Channel	Describes the various means of the company to get in touch with its customers
	Relationship	Explains the kind of links a company establishes between itself and its different customer segments
Infrastructure Management	Value Configuration	Describes the arrangement of activities and resources
	Core Competency	Outlines the competencies necessary to execute the company's infrastructure business model
	Partner Network	Portrays the network of cooperative agreements with other companies necessary to efficiently offer and commercialise value
Financial Aspects	Cost Structure	Sums up the monetary consequences of the means employed in the business model
	Revenue Model	Describes the way a company makes money through a variety of revenue flows

3.1 Case Study Environments

PSM Co.¹ designs imaging systems, including X-ray, ultrasound and magnetic resonance machines that enable radiologists and cardiologists to study images of the human body. The company has grown rapidly in recent years, largely through acquisitions. Today the company employs 30,000 employees and has dual headquarters in the USA and the Netherlands. While the company utilises a small percentage of OSS in their products, they see a lot of value in open source tooling. For example the company created an open source tool kit that is currently being used by a lot of companies and is more or less the standard. The open sourcing of this tool kit was done to gain additional resources on developing the tool kit. However, while there has not been much sponsorship from other companies, the feedback received from communities has helped PSM Co. raise the quality of that tool. The overall value that this company perceive as worthy with OSS is that it is good quality software and helps reduce maintenance costs as there are others outside the organization that help maintain the software. In addition, OSS speeds up innovation in the company and is an appealing way of working as there is lots of collaboration with multiple stakeholders. In delivering value to the customer, the company felt that it is important to know your customer and know what they want. This company also utilise open source practices in the distributed development of their product line – something termed inner source. This model facilitates internal collaboration and networking in an open manner between product teams in PSM. While open source software is not formally part of the company strategy, the software is considered complimentary to the core business model.

NRC Co.² currently employs 1200 staff and has activities in Finland, USA, Hungary, Germany,

¹ PSM Co. is a pseudonyms used to protect anonymity

² NRC Co. is a pseudonyms used to protect anonymity

China and Japan. In terms of OSS adoption, there has been major efforts in the area – one concerning telecommunications infrastructure and products where Linux has been used as one of the primary platforms for a wide product range. Open source software is part of the company’s core strategy and employees are actively encouraged to participate in communities etc. Presently the company is one of the biggest contributors to open source communities. The value of OSS that this company perceive as worthy are access to code, tools and innovative ideas. The Director of OS Operations there explained that OSS gives one a network where you can enhance your ideas and the technology base on which you can innovate. This allows the company to enhance the quality of their services and products to customers and also speed up time to market. Additionally, there are more benefits for the customers in the form of “openness and the possibility to work with the internals of the product, meaning hacking and doing all kinds of things for the product that they could not do if the code wasn’t available as source code. That is the value” (Director of OS Operations NRC Co.). The competences and capabilities the company deem important in delivering this value to the customer are excellent technical and communication skills. Thus, “one needs to know the innovation, the technologies, you even need to know the people working in that space to really benefit” (Head of Software Technology, NRC Co.).

Table 3: Data Sources for the Case Studies

Data Sources	
Interviews – PSM Co.	International Partnership Project Manager (three interviews) Director of Software Services Software Team Leader Program Manager Interoperability & Security Development Manager Business Architect
Interviews – NRC Co.	Director of Open Source Software Operations (two interviews) Head of Software Technology Project Officer Senior Researcher

4. ANALYSIS AND RESULTS

4.1 Why a value network of potential complementors is critical to the ability of a firm to create and capture value with OSS.

It was found in both cases that external and internal value networks of potential complementors is extremely important in creating and capturing value with OSS. Both companies consider networking to be extremely effective in facilitating value creation and capture because it allows them to access and transfer valuable strategic resources in the form of skills and expertise, knowledge, experience of others, inspiration and an enhanced reputation by being a member in the network. For example, the Software Team Leader at PSM Co., pointed out that ‘to survive we have to do this, we need to have this open model’ while the International Partnership Project Manager there explained that “you cannot do everything yourself. So therefore you need to give something to get something back”. Thus, in networking with potential complementors, companies get access to “sparring partners” outside their own company that can answer questions that cannot be answered within the organisation. While NRC Co. found that while one can utilise open source technologies and stay outside the network,

“they can take whatever is out there, a snapshot if you will and run with it. But that strategy might help you get one product out or one generation of products out but in our experience then for the next product, you need to start all over again and see what’s around and try to take a snapshot of what’s available.. and that’s a very tedious process” (Director of Open Source Services, NRC Co.).

Thus, this company find it extremely important to integrate oneself into a network of customers and communities working with the same technologies. In this way they can not only influence where the 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. Being part of an OSS network offers the company the possibility of building and improving products together. As was described by the Director of Open Source Services in NRC Co.,

“there are external people who would improve power management of our devices, you know, make the battery last longer. There are people who are working on the practical user interface because you know they have great ideas and they want to see them happening on a mobile device”.

In some cases NRC Co. have hired people from the network who are well-established household names in the community to work on open source technologies in the company. However, one of the consequences of building a technology based on open source is that if the company ceases working on the project and stops using the technology, these newly recruits may leave the organisation. Often people may have strong commitments to open source projects as they know the people involved and have built their career there and thus have more attachments to the project or network rather than the actual company.

Additionally, in PSM Co., the target customer for their company are doctors in hospitals who use the company’s equipment mainly for treatment and research purposes. Often there may be certain software the customer wants and in a lot of cases this can only be got with open source software. Thus, that there is a high frequency of networking and ongoing collaboration with third party complementors, communities, universities and hospitals. This company collaborates with universities and hospitals that do medical research, which in turn helps improve their product. In addition, they work with third party complementors who provide certain parts of the product and services, which again improves the company’s overall value creation to the customer. The company also has a very good relationship with OSS communities. The expertise and knowledge they receive from these various networks speeds up innovation in the company, enabling further value creation. As one interviewee explained “the economic value of simply sharing resources and then making something that makes everybody happy, that’s an easy sum to make” (Partnership Project Manager, PSM Co.). Additionally, the company is trying to incorporate more open innovation practices in the company and currently trying to establish some projects and relationships with one of their major competitors. In terms of the value captured, this company found that there are more valuable ideas and knowledge to be gained from networking with a larger group. Additionally, the value captured is in the form of good quality software and knowledge about the ideas behind the software, how it’s built etc. For NRC Co. the value captured from open source is not something that one can turn directly into revenue. However, one can build the value captured into more innovations and knowledge sharing which over time turn into revenue.

Furthermore, PSM Co. consider one of the biggest values of OSS to be the internal networking that has come about within the company, i.e. the inner source initiative. For example, they collaborate as a platform team with all the product teams. In this way they feel they have learned a great deal

from combining knowledge and capabilities and this is where they capture a lot of value. One interviewee pointed out that five years ago, everybody would simply “do their own thing and have no inclination of what the person next door was doing at the same time” (Software Team Leader, PSM Co.). Thus, there has been tremendous change for the company as there is a lot more awareness now that everyone can see what’s going on and as a result, there is much more efficiency in development. As the Software Team Leader in this company further explained,

“the openness of our development model - everybody can see what’s going on. There are hundreds of projects and everybody can simply see it. So it’s like Source Forge out there, but we have that internally”.

Thus, the company are getting a lot more efficiency from their development as products are been created earlier using this mode of collaboration and have been picked up eagerly by the markets. Additionally, the internal network has grown and continues to grow. With the inner source model, this company can give teams the flexibility to add things that they need in time and at a later stage, consolidate it in the platform to ensure that this value is leveraged to other teams as well.

4.2 How a greater level of commitment, volume of knowledge exchange and alignment of objectives enables value creation and capture with OSS

Again, both cases considered the level of commitment displayed by various participants in a network to be extremely influential in facilitating value creation and capture with OSS. It was found that if the level of commitment is not visible in a network, then various participants would not put in the required resources. One interviewee at NRC Co., explained that in forming networks with OSS communities,

“you need to show commitment and by default they would suspect you as a newcomer. Only through hard work, participation, commitment and playing by the rules can you show that you can be a trusted member of a community and they take you in” (Director of Software Services, NRC Co.).

Thus, long-term commitment and building trust is vital and this needs to be demonstrated continuously. It was found that if commitment is low, then the value that is created and captured is low. However, while commitment is crucial in a network, it is something that is often quite difficult. In elaborating on the level of commitment required for the inner source initiative in PSM Co., there are often some conflicts of interest that need to be addressed continuously. As the Software Team Leader in PSM Co., described:

“a product team wants to be helped at this time only for their problem. They don’t care about the platform and of course the platform is only valuable if we can deliver our results to more than one party. Otherwise there’s no point in making a platform”.

Thus, while some participants continuously contribute to the network, it is not something that is in the hearts and minds of everyone in this company. Both cases also stressed the importance of a high volume of knowledge exchange in a network. For example, there is always more ideas and knowledge exchanged in a larger group and one can learn from what others are doing which in turn is beneficial in creating and capturing more value. However, it was suggested that while one can exchange and share a lot of knowledge, this knowledge needs to be specific and precise as this is what makes it more valuable to the company. However, the Director of Open Source Software Services at NRC Co., 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”.

However, the more knowledge that is exchanged, the more learning goes on as one is learning something new and innovating on these new ideas. Having access to all this diverse knowledge facilitates superb value creation and capture because often,

“somebody else from a totally difficult context...from a different industry comes in and asks a question or proposes a solution that had 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 and do something great. That’s open source at its best.” (Director of Open Source Services, NRC Co.).

Additionally, some employees often have knowledge that would be of no real value to the company. The company would generate this knowledge to network participants who might view it as beneficial. In turn this helps strengthen relationships in the network. In terms of the inner source initiative in PSM Co., the Software Team Leader mentioned that while he viewed the volume of knowledge exchange as being important in the network, he would rather see more. He explained that often it is difficult to get people to invest time in sharing and capturing knowledge. He further pointed out that one of the ideas behind the inner source model is that,

“we add value by a platform engineer learning something about the clinical side and a product engineer learning something about the internal platform. What you very often see is that in those teams there is still segregation of that. Platform people are doing platform stuff and the product people are doing product stuff. And there’s not a lot of room there to manoeuvre. So you really need engineers that have a lot of drive themselves to look beyond their own work”.

Additionally, this company organise seminars and meetings where people from the network are invited to participate. Often the company covers the travel expenses incurred by the participants. Thus, these events display a greater commitment and facilitate a higher level of knowledge exchange between members. Similarly, while objectives need to be aligned in the network, inevitably each participant will have different objectives. For example, the Development Manager at PSM Co. pointed out ‘hospitals want to cure people and we want to sell them equipment’. The most important thing is for all participants to have a common goal and unifying vision. As one interviewee pointed out,

“we want to improve our equipment and they (hospitals) may experiment with them. They can do their treatments better. That’s the idea. We learn how to improve the system in such a way that it is of real value to the market...and these are different objectives but we both come to the same thing” (Partnership Project Manager, PSM Co.)

Similarly, both companies agreed that there has to be common ground between all members, otherwise the ‘network won’t fly’. Each participant can and will have different objectives, although all objectives need to be aligned so that all participants benefit. In other words, if there is a major split of opinion in direction, the network will fall apart. Thus, there must be a win:win situation for everyone. As the Director of Open Source Software Operations at NRC Co., 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. So it is this common goal that makes us want to stay as a company in that community and invest in that that community. We believe that with this particular technology together with this particular community we can build better products. It's as simple as that. And the minute we think that they don't add value to our product creation we will not continue participating in that project".

Both companies agreed that a clear vision and strategy is important and that it was crucial that network participants did not waiver off in different directions. If this happened, it would send out unclear messages to all members. Thus, commitment, trust and constant and repeated communication is extremely important in preventing this happening.

4.4 How effectively combining and governing resources and capabilities in a network facilitates greater value creation and capture

Involvement in OSS value networks requires an effective combination and governance of resources and capabilities according both cases. Both companies have certain rules on how to conduct and interact in value networks. For example the Director of Open Source Services at NRC Co. pointed out that,

"when we go and start to work with any new technology that has been developed outside of NRC Co., we would do an open source due diligence for that technology. We would analyse it from the legal point of view, from the software quality point of view, and from the community involvement point of view, to see if that is something that we as a commercial company can use"

Once the project becomes operational in this company, the exchange conditions for network governance tend to be more informal as employees can be totally transparent within those communities, and there are little restrictions inflicted by the company which in turn help speed up the work and promote communications in the network. Similarly, PSM Co. have a legal department that are very knowledgeable on open source and give advice on its use. In this company there are steering committees, internal reviews and formal agreements in place to oversee relationships and protect exchanges with external stakeholders. The company have a number of agreements with hospitals that do medical research with their equipment and smaller companies that provide certain parts of the equipment. As the International Partnership Project Manager there indicated,

"they innovate because we put in more requirements. Therefore they need to improve their own offering and they give us something back... hardware, software, whatever... so it's a two-way process".

Furthermore, frequent exchange through continuous interaction, shared values, commitment, trust and reciprocity is crucial in effectively combining and governing resources and capabilities in a network. Subject to successful reviews by this PSM's legal department, the exchange conditions that follow are very informal, especially at the operational level. As was pointed out, "engineers just co-operate and the managers struggle as this is where the politics start" (Director of Software Services, PSM Co.). Similarly in NRC Co., most exchanges in networks occur via the Internet – people exchange code, email and often phone calls. As people in the network are located all over the world, it is obviously very difficult to get people around the same table. However, this process is something that is managed very well in NRC Co. Additionally, these forms of communication create a visible and transparent record of participants' activities within the network.

In describing the success of the Eclipse Open Source Network, a network that comprises over 80 members including NRC Co., the Director of Open Source Software Services there described how the governance model was one of the most unique characteristics of this network. He outlined how:

“the open nature of the network made it very easy for different people to participate in.. and even competitors because the governance of that network and the working model made it very easy for competitors to come and join...everybody knows the rules. It’s an open place. Everybody can plug in their little technology and everybody can enhance their technology. And nobody can take that home and turn that into a competitive advantage in the wrong way”.

In the case of Eclipse network, IBM played a significant role as leaders in establishing this network. Both cases agreed that strong leadership, playing by the rules and a win:win situation is a prerequisite for any network. In the context of the inner source initiative in PSM Co., the Software Team Leader that,

“irrespective if you are going to use the platform or not, you are simply going to pay a platform tax which will stimulate you to actually use the platform, because then you get something back”.

This mode of control is very important and without it, the model would not work. In addition, if more incentives were offered in the company to keep people motivated in contributing to the platform, the model could be a lot more effective. However, while managers in PSM Co. see the necessity of the inner source initiative, often they are in their job position because they are good at controlling things and setting up structures to regulate things and ensure they have results. As was pointed out “that type of personality is not necessarily the best in an open innovation kind of model” (Software Team Leader, PSM Co.). However while this company used to be quite black box, the development process is now very open. As was further pointed out,

‘it’s all out there. Everybody can take a look at it. We have a wiki to share knowledge, best practices on how to use the platform, technical details about the platform, those kinds of things. We use support mailing lists to have people help each other so you see product teams helping each other and therefore, the community affect growing” (Software Team Leader, PSM Co.).

5. DISCUSSION AND CONCLUSION

As is apparent from the analysis in section 2, the traditional methods for analysing value creation and capture are not suitable for open innovation environments such as OSS. For example, they take no notice of a value network despite the apparent importance of network-based activities between customers, suppliers and third-parties for successful value creation and capture with OSS. Therefore, we identified the need for a value network in order for firms to accomplish both processes, and specified our conceptual model as three propositions (see Figure 1). As each framework only offered a partial explanation of value creation and capture, we felt that the business model lens served as a very effective approach to better exploring and understanding value creation and capture with OSS. This is due to the fact that it builds on and integrates different theoretical perspectives and also considers the role of a partner network. Gaining access to a value network of potential complementors is crucial for value creation/capture. A value network enables firms to access and transfer a number of key strategic resources such as skills, competencies, expertise, knowledge etc. that in turn enables the delivery of the ‘whole product’ and services to the customer. Network participation is focused on enabling rich, transparent and honest interactions between all participants unlike the transaction-oriented focus of the TCE and value chain frameworks. Indeed, it was evident that both case study environments valued non-monetary rewards like access to code,

innovative ideas, knowledge etc. as being more important than actual revenues. Additionally, as there is no existing research on the concept of open innovation within the organization, the study has been beneficial in this regard. The use of inner source, which we consider an exemplar of open innovation, facilitates internal networking and open knowledge-sharing among all employees in the organization. Thus, future research should explore this phenomenon in more detail.

To conclude, this deliverable has focused on applying the theoretical ideas behind value creation and capture in general to better understand OSS value creation and capture processes. In addition, we compared and contrasted these approaches with the theoretical ideas of open innovation to better understand the role of value networks in facilitating such value creation/capture. While a recent phenomenon, we consider open source software and inner source to be excellent exemplars of open innovation. As the digital ecosystem concept promoted by the OPAALS community differentiates itself on the basis of its open source and peer-to-peer nature, the empirical findings revealed in this deliverable are beneficial for the OPAALS community and the wider research community as they lead to a better understanding of the value component of OSS business models, in particular how firms create and capture value. Additionally, the deliverable explores the role of value networks and the network characteristics that facilitate value creation and capture, something that has direct implications for comprehending and sustaining digital ecosystems. For example, it is evident from the case studies that successful value creation and capture in a network depends on the level of commitment, volume of knowledge, a common goal and how well a firm's objectives are aligned to other partners in the network (characteristics that are also important in sustaining digital ecosystems). For example, network participants need to exhibit a high level of commitment before they can become trusted members of the network. Additionally, a high level of knowledge exchange strengthens relationships in the network and facilitates more commitment among participants. A common goal and alignment of objectives is also extremely important in terms of getting participants to stick to the network and invest time and resources in sustaining it. Finally, firms can generate and capture more value through the effective combination and governance of resources and capabilities of all actors in the network. Once firms overcome the legal mechanisms involved in exchanging resources in a network, the exchange process becomes more informal and is coordinated around social mechanisms that provide high visibility and transparency for superior value creation and capture for all members.

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